SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, JULY 3, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

J. PETER LESLEY.

PROFESSOR J. PETER LESLEY, born in Philadelphia, Pa., September 17, 1819, died in Milton, Mass., June 1, 1903.

After graduation at the University of Pennsylvania in 1838, J. P. Lesley served as aid for a year on the First Geological Survey of Pennsylvania. In 1840 he was assigned to independent work in the complicated northeastern area for several months, after which he was associated with Mr. James T. Hodge in the coal region of the southwestern counties. During the next year he made a reconnaissance of the coal deposits in western Pennsylvania and closed the season's work with a revision of Whelpley's studies in the anthracite region.

The abrupt ending of the survey in 1841 scattered the assistants, and Lesley went to Princeton Seminary, where, to use his own words, he 'indulged in the luxury of a course in theology.' But while studying theology he had no opportunity to neglect geology; his skill as a geological draughtsman and his familiarity with the conditions in a great part of Pennsylvania made him indispensable to Professor H. D. Rogers, who was striving to secure publication of the final report. Every hour which could be spared during term time and the whole of the vacations of 1842 and 1843 were devoted to preparation of the Penn-

sylvania geological map, to reduction of vertical sections to a uniform scale and to construction of cross-sections.

Having completed his theological course, Lesley was licensed to preach in 1844 by the Presbytery of Philadelphia and at once went to Europe, where he made a pedestrian tour through France and Germany, which he rounded out with a brief course of study at the University of Halle. Returning to America he undertook colportage work in northern Pennsylvania for the American Tract Society, which he pursued with characteristic energy and success for two years. In December, 1846, Professor Rogers asked him to come to Boston, where for five months he prepared duplicates of the state map and of the geological sections, which were to be deposited in the State Capitol at Harrisburg. While in Boston he received and accepted a call to the pastorate of the Congregational church at Milton, Mass., where he remained until 1851. In this interval his views respecting some theological questions developed along lines not wholly acceptable to his ministerial associates, so that at the end of four years he resigned his charge, abandoned the ministry and returned to Philadelphia, where he began practice as a consulting geologist. At once his services were sought again by Professor Rogers, who had obtained an appropriation for publication of the final report, and for more than a year he was engaged upon revision for that report.

Thenceforward for forty years his labor was incessant; there seemed to be no limit to his capacity for work. He was recognized at once as the most competent of geological experts and his time was fully retained. Yet from 1855 to 1859 he was secretary of the American Iron Association, for which he published in 1859 a huge volume, the 'American Manufacturers' Guide,' a remarkable compendium of theory, practice and statistics, which even now is of great value. For twenty-seven years he was secretary and librarian of the American Philosophical Society, rarely absent from meetings and seldom failing to present a paper or to take part in the discussions. He made elaborate surveys of the Cape Breton coal field, of the Pennsylvania Coke region, of the Cumberland Valley iron ores, of the Tennessee coal area, of the North Carolina iron ores; while he found abundance of time to learn several languages and to prosecute special studies in various departments of literature and philosophy. In 1872 he was made professor of geology and dean of the faculty of science in the University of Pennsylvania; but in 1878, owing to the pressure of other duties, he resigned the deanship. The Second Geological Survey of Pennsylvania was authorized in 1874, and he was placed in charge of the work. This post he retained until 1893, when sudden and complete failure of health compelled him to relinquish it. He retired to Milton, where he remained until his death.

His labor was unremitting during the twenty years of service upon this survey. He read the report of every assistant and prepared most of the admirable indices which make those reports so available; in many cases he drew the base for the maps and sometimes even transferred the outcrop lines from manuscript sent in by the field assistants. He maintained that there was no other way by which he could acquire complete mastery of the facts contained in the reports. He wrote long prefaces to most of the volumes, discussing the results, and in several cases he rewrote reports that the matter might be presented in a more systematic way. These prefaces and editorial notes did not always seem to the authors to be either necessary or val-

uable, yet, after a score of years, it must be conceded that not a few of the suggestions, which were most unsatisfactory at the time, have proved to be of lasting value. As if these occupations were not enough, he made frequent field studies, delivered many addresses and lectured to the college classes. Such unceasing toil told even on his extraordinary constitution; several times he was compelled to abandon everything abruptly at the close of the winter's work and to flee to Switzerland, where, with Desor and other friends, he would spend two months of absolute freedom from all care—but only to return to work at the same terrific pace, to make ready for another collapse.

The hundred volumes of reports giving the results of the Second Survey are his monument. He gathered around him a group of earnest workers into whom his own spirit was infused; in most instances he gave them free scope and was repaid by honest investigation. At the close of the survey work he undertook to prepare a final report; but the close application, which he deemed necessary, brought on the final break after he had completed the report up to the end of the Lower Carboniferous. In this marvelous compilation he gave a synopsis of every assistant's work, according unreserved recognition to each observer and frequently showing an unselfish neglect of credit due to himself for earlier discovery of facts and determination of principles.

Keen in perception, quick in comprehension, Professor Lesley at times reached conclusions too hastily, but no man was quicker than he to acknowledge an error. His broad reading and tenacious memory made him a well-furnished scholar; his cheery disposition made him an attractive companion. He knew little of the world and cared less for it; he was a typical student, who in worldly matters never outgrew his college days. Honest and true, he never remembered an injury, he never forgot a kindness. His faults were those of a whole-souled generous man.

For ten years Professor Lesley was laid aside from all labor, but he bore his affliction with more than patience and at last he passed away peacefully, without suffering, literally crossing the threshold in sleep.

In 1849 Professor Lesley married Susan I. Lyman, of Northampton, Mass., who, with two daughters, survives him.

JOHN J. STEVENSON.

AN ASPECT OF MODERN PATHOLOGY.*

IT is a truism to assert that the great progress made in pathology during the past century is the result of the study of cellular structure and activity. The close of the nineteenth century has witnessed no lessening of the interest of pursuit of this study; but it has seen arise an endeavor to penetrate more deeply into the nature and properties of cells through which their manifold activities are brought about. Armed with a rich harvest of facts and methods supplied by physiological chemistry, investigators have attacked the question of the internal constitution of the cell with renewed vigor, and the degree of success of this effort is indicated by the strides made within the past two decades in unraveling the phenomena of immunity and allied states. The twentieth century has received from its predecessor a rich heritage of facts and principles relating to the intimate structure and function of cells, which is destined to yield a fruitage of great importance to physiology, pathology and practical medicine

I find myself in the enviable attitude of dealing with certain topics in experimental

* Read at the annual meeting of the Medical and Chirurgical Faculty of Maryland, April 24, 1903.

pathology, of recent acquisition and somewhat obscure nature, possessed by the assurance that my audience can afford to dispense with an explanatory introduction because of its acquaintance with the newer facts of immunity in relation to pathology, so brilliantly dealt with in Professor Welch's Huxley lecture.

So many pathological phenomena have, in the past, been attributed to alterations of the blood, and recent discovery has added so largely to the list of the activities of this fluid, that one is tempted, as he views the wonderful properties with which it is endowed, to exclaim with Goethe: 'Das Blut ist ein ganz besonderes Saft.' The manner of the solution of blood corpuscles brought about by alien serum is a well-known phenomenon that many years since, through the studies of Landois and others, was made to explain the unsuccessful and even disastrous effects of blood transfusion. More recent investigations have shown that by a process akin to artificial immunization to bacteria, a similar but more intense capacity of bringing about solution of blood corpuscles can be developed in blood serums which naturally do not possess this action, and increase of the power can be produced in serums in which it is already present.

This solution consists in the liberation of hæmoglobin from the stroma of red corpuscles and its diffusion through the fluid, a process to which the name 'hæmolysis' has been given. Careful observation of this phenomenon has shown that, in many cases, a state of coalescence of the corpuscles, to which the name 'agglutination' is applied, precedes that of solution; and, further, that while these changes are often associated, yet one may occur in the absence of the other.

While, under normal conditions, the serum of an animal is without injurious action upon the corpuscles suspended in it, yet in certain pathological states the serum suffers an alteration through which its corpuscles are acted upon injuriously, are made to agglutinate, and even to undergo complete dissolution. Coincident with the appearance of this activity, it often happens that the serum has acquired increased power of solution over corpuscles of a foreign nature; and this alteration in properties acquired by the serum is held responsible for the blood destruction that accompanies many of the infectious diseases, and is so apparent and serious a condition in certain diseases—*e. g.*, severe anæmias, the causation of which is still unknown.

In view of the acquisition of such new and hurtful qualities by the blood serum, the discovery in cultures of many kinds of pathogenic bacteria of hæmolytic and agglutinating substances for red corpuscles is a peculiarly welcome addition to our knowledge of blood destruction in disease. And while this knowledge has not led to the understanding of all forms of blood destruction, and has as yet failed to shed important light upon certain clinical types of severe and pernicious anæmia, we have obtained a new standpoint from which to view the so-called blood diseases that promises further progress in the near future.

It is common experience in science to find that accurate observation has preceded adequate explanation. The manner of action of bacterial agents upon red corpuscles, and our recently acquired knowledge of agglutination of cells in general, could not fail to suggest that certain kinds of thrombi are produced by a form of coalescence of corpuscles; and I was not, therefore, surprised to find unmistakable evidences of agglutination of red corpuscles in the blood vessels of the intestine and other organs in typhoid fever, in the lung in lobular pneumonia, and in some other

pathological conditions in man. That a similar form of thrombosis plays an important part in experimental pathology could be shown by studying the 'clots' formed in the heart and great vessels in poisoning by ether, alien serum and ricin injections in rabbits, and has been proved by the observations made by Fisher, working in Dr. Welch's laboratory, of the occurrence of such thrombi in experimental infections with the typhoid bacillus, and Boxmeyer, of Boston, of their existence in relation with certain necrotic foci in the liver in experimental hog-cholera bacillus infections. Heüter and Klebs and Welch had, many years ago, drawn attention to the fact that certain of the so-called hyaline thrombi appeared to be composed of fused and altered red corpuscles, observations which are confirmed and explained by these later findings.

It seems to me highly probable that agglutinative thrombosis will, in the near future, be recognized as an important pathological condition in man, and that a large number of the thrombi that arise in the course of infectious disease and, doubtless, diseases of uncertain etiology, will be discovered to have originated in agglutination. Not only will capillary hyaline thrombi be explained upon this basis, but the thrombi of larger vessels, such as those of the femoral vein, may equally be shown to have this mode of origin. I wish, in this connection, to draw attention to the unsatisfactory nature of the data relating to the mycotic origin of thrombi with which French writers especially have identified themselves, and to suggest that in agglutination a more adequate cause for thrombosis might come to be found.

The experimental study of agglutination seems capable of shedding much needed light upon the subject of intravascular clotting in general. I have been able to show that the so-called coagula which appear in the heart in experimental ether and alien serum poisoning are not clots in a true sense, but merely masses of fused red corpuscles; and Ehrlich many years ago endeavored to explain the lesions of experimental ricin poisoning upon the basis of his findings of capillary thrombi composed of agglutinated corpuscles. Ehrlich's attention was called to this appearance by the previous observations of Kobert and Stillmark upon the precipitating and coagulating effects of ricin upon red corpuscles *in vitro;* but the entire series of pathological effects of ricin upon the organism can not, as I pointed out some years ago, be explained by thrombosis.

That relation exists between extensive blood destruction and agglutinative thrombosis, the mode of action of ether and alien serum injections in producing rapid death quickly proves; and the essential identity of the agglutination produced *in vitro* and in the body by agglutinating and hæmolytic substances can be easily shown. If a dog or a rabbit is injected with a fatal quantity of hæmolytic serum and the gelatinized blood in the heart and great veins be removed and subjected to immediate examination in the fresh state, the corpuscles will be found fused together and, under the influence of the pressure of a cover-glass, to undergo extraordinary changes in form and position. Any one acquainted with the remarkable photographs of Mitchell and Reichert illustrating the effects of venom upon red corpuscles will recognize the identity of the two pictures.

The description of agglutination of corpuscles by venom given by Mitchell and Reichert, and later by Mitchell and Stewart, in their papers on venom, and the studies upon venom recently conducted by Dr. Noguchi and myself, suggested a re-

study of the intravascular clotting of blood caused by venom injections. We were fortunate in having several kinds of venom with which to undertake this investigation. It has long been recognized that the venom of the viper family, to which our rattlesnake belongs, is especially prone to cause vascular clotting. Besides crotalus venom we have possessed other viper venoms—such as that of Russell's viper from India (*Daboia Russellii*) and *Trimere surus* from Japan. By far the most active venom in this respect is that of Russell's viper, as intravenous injections of it cause almost instantaneous 'clotting' of the blood in the right heart, pulmonary artery and vena cavæ. If these clots are removed immediately and examined (1) in the fresh state, and (2) after instantaneous hardening, no fibrin can be found. They consist exclusively of masses of agglutinated red corpuscles and are entirely free from evidences of clotting in the classical sense. But besides the change in adhesion of the corpuscles, still greater alterations of form and refraction have taken place in them; and sections of the 'clot' from the heart and in the vessels of the lung show extraordinary pictures of drawn and twisted bands of hyaline appearance which may readily be mistaken for modified fibrin.

These facts would seem to be of immense assistance in explaining the origin of certain thrombi met with in man in infections and other diseases, which are attended by marked blood destruction, and perhaps still other changes in the composition of the blood.

The light which the study of agglutinines has shed upon the general subject of thrombosis has served also to illuminate in no trifling way the path along which we are proceeding in gaining knowledge of certain forms of hæmorrhage. It is customary to ascribe hæmorrhages to two opposed conditions—to rupture of blood vessels and escape of blood corpuscles through the vessels by diapedesis. Only the second mode of origin needs enlightenment. Hitherto we have been obliged to be satisfied with a vague and hypothetical molecular alteration of the vascular wall as explaining the increased passage of red corpuscles into the tissues. It would now seem that at least certain forms of parenchymatous hæmorrhage are explicable in a more satisfactory and objective manner; and I will ask you kindly to turn your attention to this subject.

That no necessary relation exists between thrombosis and hæmorrhage can be shown experimentally by removing from rattlesnake venom its agglutinines for red corpuscles, when the hæmorrhage principle is left unaffected; and that no relation exists between hæmolysis and hæmorrhage can be inferred from the action of cobra venom which, while an active agent of blood destruction, causes but little hæmorrhage. But the entire independence of the principles which act injuriously upon blood vessels, and thus permit escape of blood, can also be shown by the use of ricin, which is non-hæmolytic, and which, in rabbits, produces extensive extravasation of corpuscles into the serous membranes.

Jacoby and Müller have shown that ricin is not robbed of its entire toxicity by digestion with artificial gastric juice, and Müller made the observation that the agglutinine is destroyed in the process. I found no trouble in confirming this finding of Müller, and in detecting that digested ricin is still capable of producing hæmorrhage.

If the thin mesentery of the rabbit is spread out and prepared and the capillaries lying within the hæmorrhagic areas are carefully studied, it will be seen that in neither venom nor ricin poisoning have

the red cells become fused and lost their independence, but the capillary walls have been injured in a definite and unmistakable manner. The extravasations take place not by diapedesis, as is now believed, but through actual rents in the walls. The explanation of the rents is of much interest. That they are not simple ruptures seems proved by the disappearance, as if through solution, of the parts of the walls at the site of the escape of corpuscles. The solution of continuity is one-sided, and in some instances is attended by a displacement of the adjacent endothelial cells, which are pushed outward, away from the vessel, by the force of the escaping blood. The escape of corpuscles by dissolution of the vascular walls is limited to capillaries and small veins. When acted upon by venom the vessels show irregular bulging of the walls, by ricin a localized dilatation or congestion of the vessels, which give rise to a glomerular appearance; but in a small number of places only does the extravasation occur. It is probable, therefore, that the points of injury to the vascular coat are many, but in a part only of these does the vessel give entirely away.

The existence, then, of a substance having an especial affinity for vascular endothelium may be considered as proved for snake venom and ricin. For this principle, if principle it be, we have proposed the name of hæmorrhagin, and we look upon it as a cytolysin for endothelial cells of blood vessels, the injury and destruction of which is the direct cause of the escape of blood into the surrounding tissues. It remains to be shown whether such hæmorrhagins are of common occurrence in nature, and to what extent they may play a part in animal pathology. I regard this as a most promising field of future exploration, for I conceive that bacteria and other pathogenic microorganisms probably produce endotheliolysins, and the action of hæmorrhagins may be the immediate cause of the extravasation of blood in purpuric states and some other forms of so-called parenchymatous hæmorrhage.

Should this view of the causation of hæmorrhage be supported by future studies we may well consider the possibility of preparing experimentally an antidotal agent for the principle involved in its production. We already have at hand certain observations bearing upon this question. You are all familiar with antivenin as prepared by Calmette and Fraser as an antidote to venom. Although contrary to the generally prevalent opinion, it may be affirmed that the value of the commercial antivenin is in inverse ratio to the hæmorrhage-producing power of the venom. This fact arises from the consideration that in the preparation of antivenin, cobra venom chiefly is employed, and it is almost devoid of the hæmorrhagic principle.

Venoms which cause much hæmorrhage exert a very destructive local effect upon the tissues. For this reason very little success has attended the efforts to produce an anti-toxin for viper venom. On this account, Dr. Noguchi and I have sought a means of modifying viper venom so as to remove the locally destructive effect and yet leave the value of the hæmorrhagic principle with which an immunity might be established. Through the use of hydrochloric acid we have succeeded in getting rid of the local effects, including the hæmorrhage, and yet have preserved the combining value of the hæmorrhagic principle, so that successive injections in animals of modified venom could be carried out. The serum of these animals contains an appreciable quantity of anti-hæmorrhagin as well as other antidotal principles, and is capable of neutralizing the local effects of rattlesnake venom.

That anti-hæmorrhagins, like other anti-toxins, etc., could be produced experimentally must be inferred from Ehrlich's production of anti-ricin; for although he failed to distinguish between the hæmorrhagic and agglutinating principles in ricin, yet the neutralizing value of his anti-ricin seems to have included all the ricin principles.

If I have dealt somewhat fully with this topic it is, first, because of its importance to human medicine, and second, because in its light I must regard the outlook for a better understanding of a very obscure, serious and difficult pathological condition in man as of considerable brightness. Moreover, it may not be an Utopian dream, in view of what has already been gained, to look forward to the production of an antidote that, by neutralizing this poison for vascular endothelium, may provide a rational and certain therapeutic agent to combat this form of hæmorrhage.

I shall ask you to turn to another aspect of my theme, which relates to the occurrence, under natural conditions, of a whole host of cell-destroying—cellulicidal—substances in blood serum which, up to now, have received almost no attention, and which I regard as not without significance to human pathology. When one considers the diversity of agglutinines and solvents for blood corpuscles, bacteria and other cells contained in normal serum or open to experimental production, it will cause no great surprise to learn that the serum of warm- and cold-blooded animals contains corresponding active principles for kidney, liver and testicular cells. Dr. Noguchi and I have been engaged, during the past winter, in studying these cytotoxins, and have found them to have a wide distribution and to possess a considerable degree of activity.

In view of the ever-increasing number of activities with which almost daily discovery is endowing our body-fluids, the question of the independence and specificity of their constituent active principles has come to be an important one. In the studies under consideration we could show, by means of absorption test, that the agglutinines and solvents for blood, kidney, liver and testicular cells differ among themselves, and the removal of a part of them by means of certain of the cells does not prevent the action of the serum upon the remaining cells; from which it could be concluded that these principles are at least specially adapted to given cells. A general reduction in the activity of the serum which has lost a part of the solvents also suggests that they are not specific in the strictest sense.

It would carry us too far afield to discuss the different ways in which the manifold properties of serum may be explained; whether by supposing it to be a mine of diverse substances as rich as the endless activities which it exhibits, or whether its effects are produced by combinations and permutations among a smaller number of independent bodies. It is sufficient for the moment to have drawn attention to the multiplicity of the energies of serum in a relatively narrow circuit, in order that I may add a word upon what may not be an impossible form of activity, developed under pathological conditions, within the serum.

In speaking of blood destruction, I emphasized the absence from serum under normal states of cytolysins directed against its own cells, and took under consideration the pathological conditions under which a destructive property was apparent. Whether similar harmful properties for the organic cells are developed in serum has not been considered especially, but in view of the diverse activities of bacterial and other poisonous agents, they may well be

assumed to arise. But just as not all the forms of blood injury can be ascribed to the action of exogenic poisons, it is worth while inquiring whether any conditions may arise under which the injurious power of serum may be directed against its bodily organic cells.

You will not have failed to appreciate the dangerous nature of the forces inherent in serum, but fortunately for us these implements of destruction are not turned against ourselves. The protection which the body exercises against these weapons of offense is aptly described by Ehrlich as 'horror autotoxicus'—horror of self-poisoning. Were it conceivable that the body should be withdrawn, for an appreciable interval of time, from the operation of this restraining force we might, at any moment, be observed to run together and dissolve in our own juices! And yet, is it wholly without the realm of possible accidents that in respect to some organs and in some degree this 'horror' should be removed? I can not convince myself that in the progressively degenerative lesions of the body —those of the liver, kidney and brain, for example—where through years the process of destruction goes on, and where the reserve regenerative capacity normally present is held in check, that this 'horror' may not be in abeyance.

The many observations upon the effects of iso- and hetero-lysins—as for kidney and liver cells—about which there is no reasonable doubt, speaks, it seems to me, in favor of such a possibility. Dr. Pearce has studied through many months, in my laboratory, the action of nephrolysins, and has made observations of great importance with reference to experimental nephritis. The results of his studies will appear in due time, but I wish to refer to one fact brought out by his investigations that I think of especial interest.

A large part of the studies were made upon dogs, and by the way of preliminary observation, the urine was always examined before the experiment was begun. It was surprising to discover not infrequently albumen and casts in the urine of dogs apparently in the best of health; and on studying the kidneys, to find marked degeneration of the epithelium, and focal accumulations of cells of the plasma-cell type, such as occur in man in a definite form of non-suppurative interstitial nephritis.

The blood serum of normal dogs infused into other healthy dogs produces no symptoms nor disturbance of the renal function. But the serum of a dog with spontaneous nephritis gave rise to albuminuria and cast excretion, such as Dr. Pearce has observed in many instances of the infusion of the serum of the rabbit which had been treated previously with washed dog's kidneys.

That both iso- and hetero-nephrolysins set up the lesions of acute nephritis had been shown previously; but this observation of Dr. Pearce is of a different order. It must be considered either that some exogenic toxic agent set up the renal lesions in the first dog, and was present in the animal's blood in such quantity that, when its serum was infused in the second animal in the proportion of 1 to 500 of the body weight, it sufficed to produce marked disturbance of the renal function, such as is recognized in man as due to organic lesions; or that the degeneration of epithelium which may be assumed to exist in the first animal (which is still alive and under observation) provoked a series of changes with the production of toxic substances which for this animal are autotoxic and another animal of the same species isotoxic. It will not do to dogmatize about phenomena as complex as those we are now considering; but if the second view expressed

here is at all tenable, and it would seem to offer at least a rational explanation of the facts observed, we must admit the possibility, under pathological conditions, of the establishment of a vicious circle leading to progressive degeneration of organs, which could come into play only by the temporary suspension of 'horror autotoxicus.'

But I must turn from such baneful and, at present, perhaps, unprofitable speculations. The whole subject to which they refer represents a field of future exploration. That it is a territory not without fascination you will, I think, admit; and I am of the opinion that it is also a land of promise for the future of practical medicine.

The enormous advances made in the last decades in the study of the morphology of the cell are being paralleled by the gains in our knowledge of what may be called intracellular chemistry. This new knowledge is bearing the richest fruits, for among them are the newer conceptions of immunity, and of the physiological and pathological activities of a whole series of intracellular ferments.

Looked upon broadly, the corner-stone of modern pathology is toxicology. Without entering into a discussion of the general subject, I may remind you that while definite chemical poisons, such as arsenic, morphia, strychnia, etc., are capable of inflicting great injury upon different organic cells, their introduction in repeated feebly toxic doses into the body is not followed by a reaction the results of which are the appearance in the blood and elsewhere in the body of neutralizing and antidotal substances. The case is wholly different with a series of less definite, chemically speaking, toxic agents of which diphtheria and tetanus toxins, ricin and venom, and pathogenic bacteria and other cells are examples, for when introduced into the living body in this manner, they give rise to antitoxic and destructive substances to which the names antitoxin and cytolysin are being applied.

The precise manner in which these antagonistic bodies come to be produced is, for the present, purely speculation. But the lateral chain hypothesis of Ehrlich, which attempts to supply a graphic conception of the manner of their formation, has, whether expressing the truth or not, led to great advances in our knowledge. According to this hypothesis, the antitoxins, intermediary bodies, agglutinines, etc., are yielded by certain constituents of cellular protoplasm within the body, designated 'lateral or side chains' or 'receptors,' which combine with the protoplasmic constituents of body cells, bacteria or toxins used for immunization. This conjunction seems to injure or render useless the receptors of the cellular protoplasm without, at the same time, so seriously damaging the cell as to prevent regeneration. The regenerative process does not exactly restore the integrity of the cellular protoplasm, but, in keeping with the general law of regeneration enunciated by Weigert, there tends to be formed similar bodies in excess. The excessive or lateral chains, being useless to the cells in which they are produced, are cast off and appear in the body juices as intermediary bodies or 'ceptors,' which, according to their nature, are designated uniceptors (antitoxins, etc.) and amboceptors (intermediary bodies).

In antitoxic neutralization direct union between the toxin and antitoxin occurs; while in bacteriolysis and other forms of cytolysis there is conclusive evidence that, although the intermediary body unites first with the cells, this substance by itself can not bring about injury or solution, but after its union with the cells the substance called 'complement,' normally present in

the blood, is capable of being brought into action, whence the injury is inflicted. The action of the complement depends upon its possession of properties designated zymotoxic and toxophoric, through the influence of which hæmoglobin is set free from red corpuscles, various organic cells are dissolved, bacteria are disintegrated, and ciliar and flagellar motions are suppressed.

The intermediary bodies and complements upon which serum activity depends are contained within the blood; but there are certain kinds of natural poisons, of which venom is perhaps the best example, in which only the intermediary body occurs in the poison, the complement—the directly hurtful constituent—being supplied by the blood. I have already dwelt upon some of the principles of this poison, and I wish now to state briefly that venom possesses intermediary bodies capable of bringing into play complements which cause solution of many kinds of cells—those contained in nervous, renal, hepatic tissues and still other organs. All these solvents, as Dr. Noguchi and I have been able to show, possess a striking independence of action which can not fail to excite great wonder at the complexity of venom, and aid in the understanding of the elective affinities which poisons exhibit for certain organs, to which not only is disease of these organs to be attributed, but the selective action of remedies ascribed.

My purpose in bringing again to your attention the subject of venom intoxication is to present a remarkable instance of interaction of two substances, both of which are poisonous, but one of which is capable of affording protection from the other; a therapeutic paradox which is explicable upon the basis of the mechanism of immunity as formulated by Ehrlich.

I have referred to the cytolytic action of snake serum, and I wish now to tell you that the blood serum of the rattlesnake, moccasin and some other snakes is highly poisonous to warm-blooded animals. Dr. Noguchi and I have been able to show that the manner of action of the toxic principles of snake serum is comparable to that of venom, with, however, one very important difference. Both owe their poisonous action to intermediary bodies; but the one, that of venom, is able to attach the complement, necessary to complete the injurious system, of the animal poisoned; while the other, that of serum, can combine only with its own complement. While, therefore, venom is active even after heating to a relatively high temperature, serum is inactivated at the temperature (58° C.) at which its complement is destroyed. This temperature does not, however, affect the serum-intermediary body; and hence, while the heated serum is no longer toxic because it can not utilize a foreign complement, it is still able to unite, through its intermediary body, with cells for which it has affinity. This affinity is especially for nerve cells; and since the serum combines with the same lateral chains or receptors of the nerve cells that venom attacks, it is possible by using heated serum to prevent a later venom union. If, therefore, heated snake serum is injected into guinea-pigs they can be protected, for a time, from fatal cobra poisoning. The duration of this immunity is not great and its degree is not high; for, on the one hand, the normal metabolism of the cell modifies or destroys, sooner or later, the combined serum-intermediary body, and, on the other, an excess of venom can by mass action drive out the weaker serum constituents. This fact is brought readily into conformity with the belief that receptors are, after all, designed primarily, not as organs to be used under stress of pathological necessity, but

to serve the needs of physiological processes of nutrition.

Snake serum protection from venom had previously been observed by Phisalix and Bertrand, who endeavored to explain the phenomenon by supposing that antivenin was produced by the absorption of venom into the circulation of those animals. According to their view, the serum contains venom and antivenin; the first easily destroyed by heat, the second more resistant. Heating of the serum, while abolishing the venom activity, leaves that of the antivenin unimpaired, whence its protective action.

There is something highly artificial in this explanation, which agrees, moreover, very badly with the facts. First, venom is destroyed at a much higher temperature than antivenin; second, the toxin and antitoxin of venom, when brought together, whether in the circulation or in a test-tube, tend to combine and neutralize each other; and third, it is possible by replacement experiments *in vitro* to demonstrate the occupation of the receptors by the neurotoxin of serum and the consequent exclusion of the neurotoxic constituent of venom.

You will, I trust, pardon me for bringing before you a subject of such purely theoretical interest. My object in doing so is to indicate the aid which the chemical idea of cell and toxine unions is bringing into toxicology. But I shall not need to apologize deeply for this liberty, since in it may be detected a purpose in pointing the way along which pharmacology and later therapeutics may be conceived to pass.

We have now traversed a considerable territory and one not wholly free from rough places. But the commanding position which we have reached, and the breadth of view into the nature of pathological processes which has been secured, justify, I trust, the undertaking. But having proceeded so far, it were vain to turn back until we have examined another field just opened up to physiological and pathological investigation, at the entrance of which we stand.

That organs protected from decomposition tend to undergo solution by a process of self-digestion was first accurately shown by Salkowsky in 1882. Within the last two years, and chiefly through the labors of Jacoby and Conradi, interest in this subject has been revived, and a number of important facts, bearing upon physiological and pathological processes discovered. Autolysis, as the process is now called, has been studied from many different sides: the nature and the distribution of the active ferments; their multiplicity and specificity; their influence upon the coagulability of the blood, upon bacterial life, upon cellular degeneration under physiological conditions, and upon the resolution and absorption of pathological products, formations and exudates. These studies have already shown that in the intracellular ferments causing autolysis we possess a most important and potent series of agents which come into play under both physiological and pathological conditions.

All that is required to convince oneself of the phenomenon of autolysis is to place a portion of the liver or other organ, or a quantity of exudate, under conditions protected from decomposition and maintained at blood heat, when digestion will proceed. Care must be exercised to avoid using means of preventing putrefaction that may injure unduly the ferments. Two kinds of autolysis are now distinguished: (*a*) Antiseptic, in which it proceeds under chloroform or toluol, and (*b*) aseptic, in which the organs are exposed in a sterile condition. Manifestly only the first method is applicable to certain pathological products in which bacteria are present. As a result of this self-digestion, the coagulable al-

bumens are converted into non-coagulable proteid, and certain by-products, among them leucin and tyrosin, make their appearance.

Differences are noticeable in the readiness with which autolysis of organs takes place under different pathological conditions. Jacoby found that liver autolysis was much accelerated in animals poisoned with phosphorus; and I have made some tentative experiments upon the rapidity with which organs from infected and non-infected human beings undergo this change.

Many of you will have been impressed with the remarkable softness presented by the liver, spleen, kidneys and other organs in persons who have succumbed to typhoid fever, peritonitis, septicæmia, etc. This softness has nothing to do with putrefaction, and I think it reasonably certain that it is the result of autolytic processes which may have begun to operate even before death. The changes through which the acutely swollen spleen, such as is met with in typhoid fever, goes illustrate very well the manner of action of these ferments. The diffluent quality of the spleen in this disease quickly develops outside the body; and it can be shown to be independent of the post-mortem growth either of the typhoid bacilli or putrefactive bacilli. Every pathologist has seen a moderately firm spleen outside the body become soft and semifluid in a few hours; and I find that, reduced to pulp and placed under toluol-water, the same change takes place.

In view of the resemblance of the hepatic lesions of advanced phosphorous poisoning to those of the liver in acute yellow atrophy, and the frequency with which the latter obscure disease supervenes upon acute infections, and, further, in view of the close agreement of the chemical products of degeneration of liver tissue in yellow atrophy with those of autolysis of the liver, the question arises whether the hepatic lesions in acute atrophy may not be the result of active autolytic processes set up by some agent that is as yet unknown.

The alterations in structure and consistence of muscle occurring in certain acute diseases (such as the so-called Zenker's degeneration which appears in typhoid fever) have features in common with changes noted in autolysis. The softening and preparation for absorption of infarcted areas in the brain, kidneys, spleen and other organs are also attributable to the action of intracellular ferments; and a similar form of softening occurs, if imperfectly, in malignant tumors, notably carcinoma, and in syphilis, where ferment action is possibly accelerated through the use of drugs, of which potassium iodide is the most efficient in use.

On the other hand, not all dead tissues are subject to this digestive liquefaction and absorption. Tuberculous foci, though degenerated, are remarkably persistent; and, as Prudden has shown, undergo softening probably only when certain bacteria invade secondarily the necrotic areas. It is of importance, in this connection, to recall that streptococci, which in themselves are not energetic tissue dissolvers, bring about softening and cavity formation in tuberculous foci; and the question as to whether their action is a direct one through products of their growth, or an indirect one by causing an increase in autolytic ferments, is pertinent but not as yet to be answered.

Fresh pus obtained, let us say, from an empyema, or fresh sputum, kept under toluol at the body temperature, becomes fluid, and a creamy layer collects upon the surface. The cells and nuclei disappear, and there appears in the fluid, as Naunyn first ascertained in 1865, various disintegration products, among which are leu-

cin, tyrosin, xanthin, guanidin, etc. Pus which thus undergoes digestion is capable of dissolving fibrin and even portions of organs independent of the action of bacteria. From this the conclusion can be drawn that pus, or really the leucocytes of pus, possess active digestive properties, a fact which the history of abscess formation and the removal by leucocytes of necrotic and other kinds of tissue, renders easily comprehensible. Many years ago Weigert attempted to explain, by assuming the operation of a peculiar poison which prevented fibrin-formation, the absence of fibrin from abscesses, etc., in which the fibrin factors must have originally been present. It is much more probable that what happens is a digestive transformation of fibrinogen, or of fibrin at the moment of its formation, by the ferments of the pus cell.

Broadly speaking, exudates and necrotic tissue are removed in two ways: (1) by absorption, and (2) by organization. In the first mode disintegration and solution of the cells, etc., with the exception of the fat and certain other elements, such as pigment, take place, and an emulsion results well adapted for entrance into the lymphatics. In the second, new vessels develop and invade the exudate or necrotic tissue, and by supplying a fresh set of leucocytes to dispose of the offending material, it is finally removed. From what has already been said, the first series of changes will readily be recognized as caused by autolysis; but the operation of the same cause is not so apparent in the second series. And yet, the two series are essentially the same. In the one the original material contains ferments of a kind and a quantity sufficient to bring about the transformation which is necessary before absorption can take place; in the second, the ferments being originally insufficient, are renewed by fresh leucocytes which emigrate from the vessels, load themselves with débris, and finally accomplish their entire removal.

There is little doubt that in many pathological conditions the leucocyte is the essential agent in bringing about absorption; and what is required to accomplish this end is not living leucocytes so much as large numbers of these cells, since autolysis proceeds independently of the vitality, as such, of the cells. The fate of pathological formations is dependent in large part on the numbers of leucocytes present within them.

The different behavior of a caseous and croupous pneumonia; the facility with which the one and the difficulty with which the other undergoes resolution is to be ascribed probably in part to the absence in large measure of leucocytes from the tuberculous process and their presence in enormous numbers in the acute inflammatory condition. Other examples illustrating the importance of leucocytes in promoting autolysis and absorption might be given.

I have been interested for the past two years in studying autolysis of the exudate in the lung in two inflammatory conditions, namely, acute lobar pneumonia and unresolved pneumonia. The pathology of the latter condition, except so far as the organization of the exudate is concerned, is, as you know, involved in the deepest obscurity. The study of the histology of the lung in various stages of the process of organization emphasizes one pathological condition, the import of which appears great in view of our present knowledge of autolysis; the exudate in unresolved pneumonia is fibrinous rather than cellular, and many of the alveoli of the lung are filled with dense hyaline fibrinous masses. All attempts to explain upon ordinary etiological grounds the peculiar changes, or absence of changes, in unresolved pneumonia, have failed; and

evidently the peculiarity of the process is to be sought in other causes.

Friedrich Müller first studied autolysis of the lung in croupous pneumonia, and described in detail its occurrence and the chemical products, among which are lysin, leucin, tyrosin, purin bases and phosphoric acid, of the digestive process. I have found that it is in the stage of gray hepatization that autolysis takes place quickly and perfectly, while in the stage of red hepatization it is very imperfect—a fact that can, I think, be attributed to the small number of pus cells present in the latter condition. But if the lung in unresolved pneumonia is exposed to conditions favoring autolysis, the process is slow and incomplete as compared with what takes place in gray hepatization. In gray hepatization, autolysis after death is a mark of the tendency during life of the exudate to become absorbed; in unresolved pneumonia the absence or reduction of autolysis is equally an indication of the future fate of the exudate, namely, during life to undergo organization.

I am, therefore, inclined to view unresolved pneumonia as an acute lobar pneumonia in which the inflammatory exudate, either because of some disproportion between the leucocytes and other constituents, or other cause as yet unknown, failing to autolyze perfectly, can not be absorbed, and hence undergoes organization.

SIMON FLEXNER.

UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC BOOKS.

A Revision of the Lepidopterous Family Sphingidæ. By the Hon. WALTER ROTHSCHILD, Ph.D., and KARL JORDAN, M.A.L., Ph.D. Novitates Zoologicæ, Vol. IX., Supplement. Issued at the Zoological Museum, Tring, April, 1903. Pp. cxxxv + 972; plates I–LXVII. 4to.

This great work, based upon the splendid collections contained in the museum at Tring, and also upon all the other large collections in Europe as well as those in America, which have been carefully consulted, has occupied the learned authors fully eight years in its preparation. It is truly *opus magnificum.* On every page it gives evidence of the most painstaking and minute research, and is the first really satisfactory attempt to collate and bring into systematic review what has been done during the past one hundred and fifty years in relation to the large and interesting family of insects with which it deals.

The work falls into three parts: The Introduction, covering one hundred and thirty-five pages; the descriptive portion, occupying eight hundred and thirteen pages; and a Synonymic Catalogue of the Sphingidæ of the World, to which one hundred and sixty-seven pages are allotted. Sixteen of the plates are devoted to figuring hitherto little-known or hitherto undescribed species. These plates are executed in photo-colortype, or by the half-tone process. The remaining fifty-one plates, which are beautifully engraved upon stone, are devoted to the illustration of anatomical details. Evidently neither labor nor expense has been spared in making the treatise one of the most satisfactory pieces of monographic work which have ever issued from the press.

The introduction has value not merely for the lepidopterist, but for all students of the biologic sciences, inasmuch as the laws and methods of procedure, which should govern in systematic work, are taken up and discussed at length. The statements which are made as to the principles of nomenclature are especially worthy of study, and the conclusions reached are such as undoubtedly command the respect and win the adherence of all those who are sufficiently well versed in this subject to appreciate the position taken by the authors.

The hawkmoths are divided into two great groups, the Sphingidæ Asemanophoræ, including the subfamilies Acherontiinæ and Ambulicinæ; and the Sphingidæ Semanophoræ, including the subfamilies Sesiinæ, Philampelinæ, and Chœrocampinæ. The 'law of priority' has been strictly applied in ascertaining the generic names, which should be used.

The result may appear, to the student who is familiar with current nomenclature, in some cases strange, if not even startling, but the evidence submitted for the entire correctness of adopting the changes from current usage is, in the judgment of the present writer, cogent, and in almost every case entirely convincing. So far as the nomenclatorial adjustments touch familiar North American species, it may be worth while to point them out.

The species named *cingulata* by Drury is referred with its congeners to the genus *Herse* Oken. The genus *Protoparce* Burmeister receives into its embrace our species *sexta* = *carolina* Linnæus, *quinquemaculatus* = *celeus* Hübner, *occulta, rustica* and *brontes.* For the species named *hageni* Grote the genus *Isogramma* is erected; for *cupressi* Boisduval the genus *Isoparce* is proposed and described; and for *elsa* Strecker the genus *Dictyosoma* is set up. For *Sphinx plebeja* Fabricius the authors propose and describe the new genus *Atreus.* Inasmuch as *Atreus* is preoccupied in the Arachnida by Koch, the present writer proposes to substitute for it the generic name *Atreides* and this name will be given to the genus in 'The Moth Book,' which is now going through the press. To the genus *Hyloicus* are referred the species hitherto generally assigned to the genus *Sphinx* in American lists. Our species *modesta* Harris, which has recently quite erroneously been referred to the genus *Marumba* Moore, is put into the genus *Pachysphinx,* which is erected for its reception. Inasmuch as the type of the genus *Sphinx* Linnæus is undoubtedly *ocellata* Linnæus (see 'Systema Naturæ,' Ed. X., p. 489), the American congeners of this species are placed in that genus, and the name *Smerinthus* Latreille, hitherto almost universally applied to them, is dropped as a synonym. As the type of the genus *Sesia,* erected by Fabricius, is undoubtedly the species named *tantalus* by Linnæus, this generic name is retained for that species and its congeners. This will no doubt provoke protest from recent authors, but the step is logical, consistent, and in fact the only one which can be taken unless the 'law of priority' is to be set aside and disregarded. The generic name *Hæmorrhagia* is applied to *thysbe* Fabricius and its allies, while the genus *Macroglossum* Scopoli, of which the European *stellatarum* is the type, is placed in the Philampelinæ, at a wide remove from *Hæmorrhagia* (*Hemaris* auctorum), with which it has hitherto commonly been associated. Our common Morning Sphinx falls under the arrangement adopted into the genus *Celerio* and appears as *Celerio lineata.*

The work deserves the most careful study, and will remain a monument to the learning and the liberality of the distinguished nobleman and his erudite colleague, who have prepared it. W. J. Holland.

Carnegie Museum,
June 12, 1903.

Variation in Animals and Plants. By H. M. Vernon, M.A., M.D., Fellow of Magdalen College, Oxford. New York, Henry Holt & Co. 1903. Pp. 415.

Since Darwin's 'Variation of Animals and Plants under Domestication' we have had no general résumé of the principles of variation. Yet this period has witnessed the rise (and fall) of many speculations on the subject, and for the past decade has yielded the solid fruits of biometric and experimental investigation.

This important gap is now filled by the well-arranged collection of data to be found in Vernon's book. These data are considered under three main headings as follows: 'The Facts of Variation'; 'The Causes of Variation'; and 'Variation in its Relation to Evolution.' In the first part some of the results of biometry are given without going into the more abstruse mathematical methods. In connection with the discussion of discontinuous variation De Vries's theory is considered in some detail. The causes of variation are classified as blastogenic and environmental, and several chapters are devoted to the latter class. In the third part the author discusses the action of natural selection on variations, and gives some of the evidence for the inheritance of acquired characters, based on the cumulative effects of the conditions of life

(where we miss the results of Standfuss and Fischer), and finally discusses adaptive variation. The author admits the importance of self-adaptations, which are, however, in his opinion, of little effect without natural selection. 'Degeneration' is a difficulty that the author does not attempt to compass, while admitting the unsatisfactory nature of Weismann's explanation. He should remember that the theory that phylogenetic 'degeneration' is due to disuse has inadequate support, and that animals with 'degenerate' organs, however produced, can still be adapted if they get into situations where such organs are of no use.

The book will be a welcome one to those who desire quickly to get at the recent literature on variation. The data are given in an impartial, sometimes even colorless way. The book lacks the vigor of the special plea and the enthusiasm of the book of one idea. It will be found very useful; but it will not found a school.

C. B. DAVENPORT.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF GEOLOGY AND MINERALOGY.

A REGULAR meeting of the Section of Geology and Mineralogy was held at the rooms of the American Museum of Natural History on the evening of April 20, with Professor Kemp in the chair. Dr. A. A. Julien presented the results of his work on the hornblende schist which occurs at the extreme northern end of Manhattan Island near Spuyten Duyvil Creek. He was able, in the first place, to prove the undoubted igneous origin of this rock by the unaltered crystals pointing to an original gabbro which it still preserves. The speaker then presented his views in favor of the igneous origin of all the hornblende schists of Manhattan Island.

The second paper was by Mr. D. W. Johnson, on 'The Geology of the Cerrillos Hills, New Mexico.' The Cerrillos Hills form the most northerly group of a series of four laccolithic mountain masses in north-central New Mexico. The relation of these hills to the associated Cretaceous beds and the age of the intrusion were discussed. A brief petrographical description of the several igneous rocks was given and the subdivision and correlation of the sedimentaries on paleontological grounds considered. The origin of the anthracite coal of the Madrid area and the origin of the famous turquoise deposits of the hills were then treated. The speaker closed with a résumé of the geologic history of the region. Professor Kemp led in the discussion which followed. Dr. H. S. Washington was asked by the chairman to calculate an analysis of the type of andesite which is found in the Cerrillos Hills.

GEORGE I. FINLAY,
Secretary pro tem.

ON May 18 the first paper was by Dr. George I. Finlay, of Columbia University, and was upon 'The Geology of the Nephelite Syenite Area at San José, Tamaulipas, Mexico.'

In this paper Dr. Finlay said in part: The town of San José in the state of Tamaulipas, Mexico, lies in a hollow surrounded on all sides by mountains, and is about seventy miles from the coast of the Gulf of Mexico. The range of peaks immediately to the south of it, and extending for fifteen miles in that direction, is of nephelite syenite. The range is known as the San Carlos Mountains. San José itself is on the site of an eroded laccolith of andesite (locally known as 'porphyry'), intruded into limestone. Some limestone masses stand on end within the areas of the laccolith, and are thought to have floated or worked their way down to their present position during the intrusion of the igneous rock. There are two or three hundred of these isolated limestone masses, and it is in connection with these that the copper ores are found. Contact metamorphism has not been developed to any great extent in the limestone surrounding the laccolith, but has been greatly induced in the included masses, marble, grossularite, vesuvianite and several other minerals being the products. Aside from the occurrence of the nephelite-syenite in the area south of the laccolith, the region is interesting on account of the dyke rocks which are found cutting the andesite of the laccolith. Among these are analcite-

tinguaites and camptonites, as well as vogesite and diabase. Two main streams now drain the hollow formed by the down-cutting of the dome where the weaker andesite has been laid bare as far as the limestone cover has been cut back.

Dr. Finlay's paper was discussed by Professor Kemp, who called attention to the fact that the character of the intruded limestone was not yet entirely clear; and by Dr. H. S. Washington, who dwelt on the interest attaching to the additional localities here and elsewhere recently reported for the peculiar dyke rocks mentioned.

The second paper of the evening was by Fred H. Moffet, Columbia University, and was entitled 'The Copper Mines of Cobre, Santiago de Cuba.'

In this paper Mr. Moffet said in abstract: The copper mines of El Cobre are located about nine miles west of the Bay of Santiago, where a series of eruptive flows, andesites and rhyolites, are interbedded with fragmental rocks, agglomerates, breccias and tuffs. The strike of the beds is east and west, and they dip at a low angle to the north. The series is cut by trap dykes and by two major systems of faults, the older of which runs east and west and carries with it the large ore bodies. The second major system has direction nearly north and south. Cross faults cut and displace the ore bodies of the older system, and carry copper, though in less amount. The copper workings of the old English mining companies produced enormous quantities of very rich oxidized ore which gave place in the lower levels to sulphides. Much difficulty is encountered in handling the mine water on account of the porous nature of the country rock. At the present time the iron ore of the region is of much greater commercial importance than the copper.

In the discussion which followed, Professor Kemp spoke of the great importance to the United States steel furnaces which these deposits possessed on account of their great extent and convenient location. The ore is extremely low in phosphorus but contains some sulphur. The copper may again be of great importance, though but little is being done at present toward its exploitation.

E. O. HOVEY,
Secretary.

ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 347th meeting was held May 12. Dr. J. Walter Fewkes, who recently returned from the West Indies, gave a brief account of his work in Porto Rico and Santo Domingo, reserving a fuller presentation till next meeting. The paper of the evening was by Dr. E. A. Spitzka, entitled 'Cerebral Characteristics of Distinguished Men, with special reference to the late Major J. W. Powell.' Following is an abstract:

Dr. Spitzka reviewed previous records of brains of distinguished men and proceeded to a consideration of their chief characteristics, particularly the brain-weight and the surface morphology—both generally and with special reference to certain cortical areas. Dr. Spitzka had tabulated the brain-weights of ninety-seven men eminent in the professions, arts and sciences; compared with the series of 'ordinary' brain-weights collected by Bischoff and Marchand, there was a relatively and decidedly greater number of heavier brains in the former series. In a further analysis it was shown that the brains of men devoted to the higher intellectual occupations, such as the mathematical sciences, involving the most complex mechanisms of the mind, those of men who devised original lines of research (Cuvier, Cope, Agassiz) and those of forceful characters like Ben Butler or Daniel Webster possess the heaviest brains. The increase in brain-weight during evolutionary progress is directly related to the increase of cranial capacity along with the development of brachycephaly. As for the cerebral surface appearances, the highly intellectual man is likely to exhibit not only a superior degree of fissural and gyral complexity in general, but of certain cortical fields in particular. These differences in the extent of certain cortical (especially the associative) areas are palpable and measurable. Particularly important in this relation is the insula (Island of Reil), probably the purest

association center in the brain, and usually showing a superior degree of development in men whose powers of speech were of a high order.

The brain of Major J. W. Powell (to be described in the *American Anthropologist*) exhibited a decidedly superior degree of development. Its weight, 1,488 grams, was above the average of the 97 brains of eminent men, and for a man below medium stature and of rather small frame and whose age was 68, it was notably above the average. The most notable feature is a redundancy in the subparietal association area (especially the angular gyre) on the right side, a feature which may not be unrelated to an important characteristic of Major Powell's mental makeup: that of keen observation and superior powers of generalizing these. A large number of charts and figures of brains of notable persons illustrated the paper.

In discussing the paper Dr. Frank Baker held that the convolutionary pattern of the brain is due to the needs of motor activity, and any conclusions from it as to brain power should be carefully weighed.

Professor W J McGee stated that Major Powell's strength lay in generalizing on observations in nature and that the address of Dr. Spizka shows that it is now possible to trace a definite relation between cerebral structure and the psychical character of an individual. Dr. Ales Hrdlicka said that it is a well-known fact that every organ in the body, if more than ordinarily exercised, receives an augmented blood-supply and in consequence tends in time to increase in size and weight. It would be very strange if the brain formed an exception to this law. It is true that the efficiency of a brain may increase by the advance of the differentiation of its minute elements, but in all probability this and actual growth go hand in hand, and the size and weight of the brain must be of considerable importance in the study of the organ. That no very definite results in this respect have as yet been generally arrived at is due to the fact that we are practically only in the beginnings of brain study and need many additional accurate data on normal material, and that not only in white but also in various more primitive peoples. We need many further data on the significance in brain study of race, sex, stature, muscularity, age as well as other factors. The significance of the convolutionary pattern is particularly in need of further investigation, yet it is a general opinion that a marked complexity of the convolutions goes with the superior brain and *vice versa*. Dr. Hrdlicka expressed a hope of establishing in the course of time a valuable brain collection in his division in the U. S. National Museum.

Further remarks germane to the topic were made by Dr. D. S. Lamb, Dr. J. Walter Fewkes, Mr. G. K. Gilbert and Mrs. Miranda B. Tulloch. Dr. Spitzka made some closing remarks. At the conclusion of the meeting a vote of thanks was tendered Dr. Spitzka. It is expected that the paper will be published in a forthcoming number of the *American Anthropologist.*

WALTER HOUGH,
General Secretary.

THE BOTANICAL SOCIETY OF WASHINGTON.

THE fifteenth regular meeting of the society was held at the Portner Hotel, May 23, 1903, with President A. F. Woods in the chair and twenty-four persons present. At the close of the business meeting, Dr. W. H. Evans, chairman of the scientific program for the evening, was called to the chair.

Dr. R. E. B. McKenney communicated 'Notes on *Saccharomyces niger*.' This rather uncommon fungus, which has been considered to be a true yeast, can by certain methods of culture be made to produce a well-developed, branched mycelium. Under such conditions the mycelium is septate, while under others it is unseptate. True ascospores were not observed; and it was considered probable that Marpmann, who claims to have found them, mistook certain refractive metabolic bodies for such spores. The formation of false zygospore structures was also noted. The fungus is capable of continued growth for a couple of months in nutrient media, which is apparently free from nitrogen. It would

seem, therefore, that *Saccharomyces niger* is to be added to the small list of fungi which are thus capable of assimilating free nitrogen from the air. Mention was also made of certain other of the nutrition phenomena of this fungus.

Dr. George T. Moore gave a very interesting address on a new method of artificially inoculating soils for legumes with the nitrogen-assimilating, tubercle-forming bacteria. The practical application of the method is very simple and was fully described. The paper will be published in full as a bulletin of the Bureau of Plant Industry, U. S. Department of Agriculture. H. J. Webber.

DISCUSSION AND CORRESPONDENCE.

THE GRAND GULF FORMATION.

In Science of December 12, 1902, Professor Dall, in commenting on our note on the Grand Gulf Formation, published in the number for November 21, 1902, calls our attention to two errors, which we now acknowledge and are very glad to correct. We made the statement that Dr. Hilgard had considered the Grand Gulf as of Eocene age. This is a mistake which escaped us both in the manuscript and in the proof-reading. Since Dr. Hilgard's work forms the basis of all our knowledge of the Gulf Coastal Plain, we knew from long-continued study thereof that there was not a line in all his writings which could be interpreted as even suggesting this age for the Grand Gulf. So also we were mistaken in saying that Professor Dall had regarded it as of Eocene age.

It is, furthermore, evident from Professor Dall's criticisms that we have not stated our case with sufficient clearness to prevent misunderstanding of our position. Inasmuch as to us the facts in our possession seem to afford absolute proof of the correctness of our conclusions, we beg to submit the evidence somewhat more fully to the consideration of the geologists interested.

At the outset it seems necessary to define clearly what we mean by Grand Gulf, and we can do no better than to follow Hilgard, who has so well described these beds, and who has correctly mapped them as covering the lower part of the state of Mississippi from the southern limit of the Vicksburg down to within a few miles of the Gulf of Mexico.

The materials of the formation are sandstones, sands and clays, with silicified trunks of trees and beds of lignite, and lignitic clays containing leaf impressions, badly preserved and incapable of determination. Concerning these Grand Gulf beds Dr. Hilgard remarks: "Two points confront us in the discussion of the relations of the formation to the sea; the great rarity of the calcareous feature in the main body of the formation, and the utterly 'unmarine' character of the materials generally, in the constant recurrence of the lignito-gypseous facies." And again, "Of the sweep of 900 miles thus outlined as the known extent of this formation, 400 may be considered as having been examined sufficiently in detail to prove the absence of marine fossils from the formation; the portion so examined embracing, moreover, its widest part and fully two thirds of the area of the outcrop." *

By the characters thus outlined, this great fresh-water formation has been recognized and described by the geologists in Georgia, Florida, Alabama, Mississippi, Louisiana and Texas. No one has had any serious difficulty in distinguishing it in the field; but every one has had difficulty in reconciling the known facts of its surface distribution with any satisfactory assignment of it to a definite place in the stratigraphic column. The only formation with which it is at all likely to be confounded is the Lafayette, which everywhere, according to Hilgard and other geologists, directly overlies it, and of which the materials are often quite similar; and we have conclusive evidence that parts of the Grand Gulf have by several authors been included in the Lafayette.

In their relations also to the underlying older strata, these two formations have much in common; for instance, they both 'blanket' a number of older formations, but the Grand Gulf, so far as yet known, overlaps only Miocene, Oligocene and Eocene as far down as

* *Am. Jour. Sci.*, Vol. XXII., July, 1881.

the Tallahatta Buhrstone, or lower Claiborne.

While, therefore, we appear to be in substantial agreement as to the *characters* of the formation which we call Grand Gulf, we differ radically from Professor Dall as to the *place* which it occupies in the stratigraphic column.

We fully concur in his statement that, "It can not be too often emphasized that no determination of the age of its (southern coastal plain) beds not based on their fauna, or the fauna of beds both above and below those in question, can be regarded as more than tentative; and such determinations in the past have almost invariably proved erroneous."

The sole purpose of our first note was to prove, by the application of these very principles, that the stratigraphic position of the Grand Gulf beds was between the Pascagoula Tertiary and the Lafayette; but since doubt still remains, we wish to offer a few additional considerations.

So far as we have been able to ascertain, the Grand Gulf beds *themselves* do not anywhere contain the fossils which afford incontestable evidence of their age. Dr. Hilgard writes:* "Apart from this [the finding of a few fragments of a turtle shell], my most patient search, in hundreds of localities, has failed to produce any fossil form; even the leaves associated with the lignite seams being so ill-preserved as to be unrecognizable."

And though casts of fresh-water shells have since been found in the formation, no determination of its age from these has been possible,† and we are thus compelled to rely wholly upon the other test, viz., the fauna of the beds below and above the ones in question.

If we consider *first* the formations which are known to *overlie* the Grand Gulf, there is not very much to be said, but it is conclusive.

The case in Texas is thus given by Professor Hill, in a recent letter: 'The so-called Grand Gulf beds of the Texas region *are not overlaid by the Tertiary*.'

In Mississippi we have Hilgard's testimony, as follows: "The latter (stratified drift or Lafayette) is found directly capping almost everywhere, the claystones and sandstones that characterize the highest part of the Grand Gulf group."

In Alabama also the Lafayette is nearly everywhere seen capping the Grand Gulf, and we have no record of anything older than Lafayette in this relation to it. The same thing is certainly true with regard to western Florida, and, we have no doubt, to the rest of Florida and Georgia as well.

In Bulletin 84 of the U. S. Geological Survey, Professor Dall says: "There is no doubt that directly in contact with the Grand Gulf beds in the Gulf states, lies the formation variously recognized under the names of Lafayette or Orange Sand of Hilgard, Lagrange of Safford, or Appomattox of McGee."

So while there are localities by the tens of thousands, in the Gulf states, where the Grand Gulf is directly overlaid by the Lafayette, we have no recorded instance of its being overlaid by any formation older than the Lafayette.

This circumstance alone affords at least presumptive evidence that the true place of the Grand Gulf is high up in the geological scale, and close under the Lafayette.

Secondly, as to the *underlying* formations. In Mississippi Dr. Hilgard found no contact of the Grand Gulf with any underlying formation other than the Vicksburg limestone. In connection with his description of these

* *Loc. cit.*, p. 59.

† Kennedy finds *V. planicosta* in Fayette sandstones, but in basal layers which Veatch considers Jackson; Veatch also, in Frio clays near Binkville, La., finds a fossiliferous (casts) layer in a ferruginous rock; Harris finds *Unio* and *Anodonta* casts at Chalk Hills, La., along with leaves of birch, willow and other dicotyledonous trees; Meyer has mentioned casts of fresh-water shells occurring also at Grand Gulf.

It may easily be imagined that the waters which were active in transporting and depositing the materials of the Grand Gulf might on occasion carry into it fossils of an older formation over which they swept. The finding of a few Eocene Miocene fossils in the Grand Gulf beds should not cause any more surprise than the finding of Sub-Carboniferous fossils, for instance, in the Lafayette, as has often been done.

contacts he points out a very significant fact, viz., "While the Vicksburg rocks show at all long exposures a distinct southward dip of some three to five degrees, the position of the Grand Gulf rocks can rarely be shown to be otherwise than nearly or quite horizontal, on the average; although in many cases faults or subsidences have caused them to dip sometimes quite steeply, in almost any direction."*

And generally in the Gulf states, the landward margin of the Grand Gulf almost invariably rests upon the Vicksburg limestone, and many sections have been published showing this contact. On the principle that, in the absence of evidence to the contrary, a formation follows next in chronological order, that formation upon which it directly rests, the Grand Gulf (or part of it) has usually been placed in the geological column, next above the Vicksburg limestone, *i. e.*, in the Miocene (or, as some now prefer to call it, Oligocene).

The application of this principle in Alabama would cause us to place the Grand Gulf at a number of horizons where we are perfectly certain that it does not belong, for while in most cases it rests upon the Vicksburg limestone, yet we have recently seen it in direct contact with the *Upper Claiborne* and upon the *Lower Claiborne* or *Buhrstone*, on the one hand, and upon the *Chattahoochee Miocene*, and directly upon, as well as far above, the *Pascagoula* (Miocene or Pliocene).

So far as we know, no one has ever placed the Grand Gulf between the lower and upper Claiborne, or between the latter and the Vicksburg. Too many sections have been described showing the contact of these formations without any intercalated Grand Gulf, to permit any such assumption.

But the relations of the Grand Gulf to the Vicksburg and post-Vicksburg Tertiary formations have, perhaps, not heretofore been fully set forth. Conclusive evidence as to these relations is afforded, we think, at the following localities:

1. *Chattahooche and Appalachicola River.*—If any part of the Grand Gulf occupies the position assigned by Professor Dall to his 'typical Grand Gulf,' *i. e.*, between the Vicksburg and the Chattahoochee limetones (or approximately at that horizon), there should be somewhere on the gulf coastal plain a section which would exhibit these beds in that relation to each other. So far as we are aware, no such section has ever yet come under notice.

Certainly we should expect to find such an exposure in that most complete and unbroken section of the later marine Tertiaries afforded by the Chattahoochee and Appalachicola Rivers. This series of the Neozoic rocks, discovered by Langdon in 1887, has been studied by a number of eminent geologists, including Professors Pumpelly and Gilbert Harris, and Messrs. Dall and Stanley-Brown, some of whom have published descriptions.

The most complete and carefully prepared account of this section is that which appears in Volume 5 of the *Bulletin of the Geological Society of America*, 'Cenozoic Geology along the Appalachicola River,' by Messrs. Dall and Stanley-Brown.

From this article we make the following quotations: "At a place on the left bank of Flint River a few miles above the Florida boundary line, known as Willey's Landing, Professor Pumpelly states that the contact between the Vicksburg and undisturbed Chattahoochee Miocene may be observed."

"Beginning at the base of the column, Professor Pumpelly has shown that the Chattahoochee series rests on an erosion surface of the Vicksburg or Orbitoidal limestone which forms the culmination of the Eocene. We have confirmed this by an examination of the fossils submitted by Professor Pumpelly."

In the '18th Annual Report' of the Director of the U. S. Geological Survey, page 330, Professor Dall says: 'There is no marked break in the stratigraphy between the Upper and Lower beds so far as yet observed.' The lower beds here referred to are the Vicksburg

* Many subsequent observations in Mississippi and Alabama confirm this, and show besides that the Grand Gulf beds, having been deposited upon an eroded surface of the Tertiaries, exhibit great variations in both the dip and the thickness.

and Ocala formations, and the upper are the Chattahoochee and Chipola.

Since no mention is made in these sections of any Grand Gulf, we may safely assume that none exists there between the Vicksburg and the Chattahoochee, and yet on the uplands, on both sides of the Chattahoochee River the characteristic Grand Gulf beds may be seen occupying the surface with the usual capping of Lafayette sands.

Mr. Gilbert Harris also publishes a good account of this river section in his 'Bulletin No. 15 of American Paleontology.'

In this article, as well as in that of Messrs. Dall and Brown, it is demonstrated beyond all question that the Chipola overlies the Chattahoochee, apparently conformably and certainly without the intercalation between them of any Grand Gulf beds; and in the same way the Chipola is conformably overlain by the Alum Bluff beds, and these in turn by the Chesapeake marl, followed by what Professor Dall calls an *aluminous clay,* which he considers as belonging probably also to the Chesapeake. "It will be seen on examination" (of the sections and diagrams) "that, while the series is not complete in any single section, taken collectively there is no gap outstanding between the beds and, humanly speaking, no room for misapprehension as to their position and age."*

Let us now trace up the Grand Gulf beds along these rivers. Nobody will deny that they overlie the Vicksburg limestone, both in Alabama and in Georgia, clear up to the Chattahoochee River where the post-Vicksburg series of marine Tertiary beds begins.

Mr. Harris† gives a section of the bluff at the old Chattahoochee Landing, in which, underneath the orange and red sands, presumably Lafayette, at the top of the section, there are some twenty feet of purplish clayey sands, and light sands and clays, which he says 'resemble Grand Gulf.' No doubt they *are* Grand Gulf, and here they overlie the Tertiary beds consisting, according to Professor Dall's determinations, of Chattahoochee and Chipola.

* Dall and Brown, *loc. cit.*, p. 162.
† *Loc. cit.*, p. 52.

Near the top of every section of Professors Dall and Brown there is shown a bed, their No. 2, which has been referred by them to the Lafayette, but which, from the descriptions, appears to include both the Lafayette and the Grand Gulf. For the authors emphasize the facts that these beds are nearly seventy feet thick, and that they are often different in composition, structure and color from the more homogeneous (Lafayette) formation to the northward.

It is safe to say then that in this Appalachicola and Chattahoochee section, from the Vicksburg limestone up to the top of the Chesapeake Miocene as shown at Alum Bluff, none of the beds which take part in the formation of the river bluffs has ever been considered Grand Gulf, unless it be those capping the bluffs, above all the Tertiaries, and covered only by the Lafayette and more recent deposits.

2. *Conecuh River, Escambia County, Ala.*—In the upper part of township 2, range 12, in this county, the bank of Conecuh* River is formed by the Vicksburg limestone, while in the lower part of the same township, some four miles distant, the bank is formed by gray sandy clays holding Miocene fossils. At both localities the Grand Gulf beds, sands, clays and lignites, overlie the Tertiary formations, and form the surface of the country intervening, with the usual capping of Lafayette.

3. *Chickasawhay River, in Greene County, Miss.*—About five miles above the confluence of Leaf and Chickasawhay Rivers on the latter stream, we have recently examined a bluff at the base of which is a shell marl, with innumerable shells of *Rangia Johnsoni,* and a few other forms characteristic of the Pascagoula horizon. Above this and forming the upper half of the bluff are typical Grand Gulf strata, sands and clays with lignite bed and silicified trunks of trees all *in direct contact* with the Pascagoula marl.

4. *Mobile County Artesian Borings.*—These borings have been made at and near Mobile and at Alabama Port. The deepest is the

* By inadvertence this was called Escambia River in our previous note.

Bascomb well near Mobile, to which we have referred in our first note. At this well the Grand Gulf, with its usual capping of Lafayette, forms the surface. The boring reaches the Pascagoula shell bed at about 700 feet, and the bed containing Oak Grove fossils (Chattahoochee) at about 1,500 feet. From the materials brought up we judge that about 180 feet at the top of this boring are in the Grand Gulf; how much, if any, more of the strata belongs to this formation we can not, of course, say, but the main point to be noted is that here the Grand Gulf lies *far above* the Pascagoula, and the latter some seven or eight hundred feet above the Oak Grove beds.

5. *The Coasts in Mobile and Baldwin Counties, Alabama, and in West Florida.*—We have already spoken in our first note of the occurrence of the Grand Gulf down to within a mile or two of the Gulf in Mobile County; of its occurrence in Baldwin County on the shores of Perdido Bay, where it makes a high bluff. Recently we have seen the same formation making the greater part of a bluff, thirty feet or more in height, on the very border of Pensacola Bay in the city of that name.

Now since a formation is bound to be *younger* than the newest formation which it overlies, and *older* than any which overlies it, we are forced by the facts adduced above to conclude that the Grand Gulf occupies a place in the geological column somewhere *between* the uppermost of the Tertiary formations as yet determined by its fossils, viz., the Pascagoula and the Lafayette. We will not even say that the Grand Gulf represents *all* the time and space between these two formations, for the borings near Mobile and the bluffs on Perdido Bay at Pensacola, show that if there are any post-Pascagoula Tertiaries in Alabama and western Florida, the Grand Gulf comes in between *them* and the Lafayette.

If any one should still maintain that the Grand Gulf belongs anywhere in the Tertiary column between the Buhrstone and the top of the Pascagoula, we think the burden of proof rests with him; he should show a single section where Grand Gulf beds, of the character described by Hilgard and accepted by all the geologists of the gulf coastal plain, may be seen intercalated between *any two* of the Tertiary formations.

If we seek to escape the legitimate conclusion from the facts above given of their distribution and stratigraphical relations, by assuming that the *fresh-water* Grand Gulf beds of the west (Mississippi and Alabama) find their *marine equivalents* further east in the Chattahoochee series, we are confronted with this fact, that at the Chattahooche River, and beyond through Georgia, the characteristic fresh-water Grand Gulf beds, such as Hilgard has described them, overspread the country just as they do to the west, showing no signs whatever of any transition into marine deposits. It is needless to seek equivalents when the thing itself is there.

And, moreover, we now know for a certainty that all across Alabama and in the type locality of Dr. Hilgard, on Chickasawhay River in Mississippi, both the *fresh-water Grand Gulf* and the *marine fossiliferous Tertiaries coexist* everywhere, the Grand Gulf above, the Tertiaries below.

The facts which we have presented above may easily be verified by a few days' field work. If they are susceptible of other construction than that which we have placed upon them, or if there are other facts incompatible with the conclusions which we have reached, we stand ready to modify or abandon our views, since we are fully aware of our limitations, and of the difficulty, almost the impossibility, of arriving at the *whole truth.* If we have made a small contribution towards it we ought to be satisfied.

No one can appreciate more than we do the great work which Professor Dall has accomplished in our southern Tertiaries, and we hope he may long continue active in the same work, and bring us finally to a certain and complete knowledge of the sequence of these formations and of their contained fossils. If we differ from him on some of the points presented above, it is because the facts seem to compel us thereto.

Moreover, we think he has hardly given due

weight to the evidence which we brought forward in our first note, and certainly he does not correctly represent our position in some of his comments on that note, as, for instance:

1. He thinks that our assumption of the late, possibly Pliocene, age of the Grand Gulf beds, if it should prove correct, is merely an equivalent of the idea of Dr. Hilgard cited by him, and, therefore, not new.

Dr. Hilgard's idea was that these beds represent *all* the time and space between the Vicksburg and the Lafayette; ours is that they represent *a very small part only* of that time and space, viz., the part between the Lafayette and the uppermost of the known Tertiaries of the Gulf coast—the Pascagoula, and very probably not even all of that. If a part is equal to the whole, then the equivalence is established, and we stand convicted.

2. "The beds which Messrs. Smith and Aldrich call 'Grand Gulf' in their communication to Science are not the same" (*i. e.*, Professor Dall's 'typical Grand Gulf') "but are the non-fossiliferous upper portion at the other end of Hilgard's Grand Gulf section."

The clays containing lignite and fossil palm leaves, described by Hilgard at Powe's on Chickasawhay River in Mississippi, have been fixed upon by Professor Dall as his 'typical Grand Gulf' beds, and have been classed by him as Oligocene (Science, December 12, 1902, p. 946). Now from this type locality Dr. Hilgard traveled southward down Chickasawhay and Pascagoula, giving details of exposures of the Grand Gulf as far as Dwyer's ferry, ten or twelve miles from the gulf. Although he then saw no contact of the Grand Gulf with any underlying formation, owing, no doubt, to the stage of the water, yet this formation may be seen, as above described, resting on the Pascagoula shell marl on the Chickasawhay, a few miles above its confluence with Leaf River. And furthermore, the Grand Gulf at this point consists of clays, sands and lignitic clays, with silicified trunks of trees. The same formation is at the surface thence back to the type locality near which it is seen resting upon Vicksburg limestone. Here then the unquestioned Grand Gulf, with Hilgard's hall-mark of genuineness upon it, rests upon the beds of Upper Miocene (or Pliocene) age, called the Pascagoula, just as they rest upon the Eocene Vicksburg limestone twenty miles further north. Both Hilgard and Johnson have given details of numerous other fossiliferous Grand Gulf beds in these parts of Mississippi. These are the beds which we have called Grand Gulf. And furthermore, we find lignites and lignitic clays with leaf impressions in the formation overlying the Miocene at Coal Bluff and Roberts in Escambia County, Alabama; we find the lignitic matters in the same beds down to the water's edge on Mobile Bay, so that certainly all the beds which we have been calling Grand Gulf *are fossiliferous* precisely as are those described by Hilgard which Professor Dall accepts as his typical Grand Gulf. Nor have we been writing about the upper part of the formation only, as the bluffs on Conecuh River demonstrate. If the Grand Gulf beds which there rest on the Vicksburg limestone be counted as the lower beds, then the beds of the same formation resting on Miocene fossiliferous sands, four miles further south, can not be very much higher up, especially in view of the fact that the Grand Gulf beds are everywhere very nearly horizontal. And even upon the assumption of a steeper dip, since the Grand Gulf covers the country down to the gulf, a distance of thirty or forty miles from the Conecuh River localities, those beds which form the surface over only four miles (or one tenth of this area) certainly would not belong to the upper portion.

3. "By means of paleontological data, * * * I have been enabled to fix the age of *different portions* of the original heterogeneous series as uppermost Oligocene (transitional) and Chesapeake Miocene, which is fully confirmed by the facts now cited by your correspondents."

Langdon's discovery along the Chattahoochee in 1887 first showed beyond all question that fossiliferous marine beds occupied a part of the geological column which Hilgard once thought to be covered by his Grand Gulf beds alone. Langdon gave the name Chattahoochee to these deposits, which he

classed as Miocene, and this determination of the age has been very generally accepted by the geologists. Professor Dall's critical studies of the fossils and stratigraphy of this region have since enabled him to give greater exactness and precision to Langdon's first outline by establishing several substages of the original Chattahoochee; by assigning the lower part of the original Miocene to the Oligocene, and the upper to the Chesapeake Miocene, etc.

Now, while the facts given by us certainly confirm the existence of Langdon's Chattahoochee beds, by whatever name now known, below the Grand Gulf in western Florida, and in Alabama and Mississippi, we do not see how they either confirm or contradict the conclusions of Professor Dall as to the true age of the different parts of the Chattahoochee series.

To summarize:

1. The Grand Gulf of 'Messrs. Smith and Aldrich' is the same fossiliferous formation which Hilgard has described by that name, and not merely 'the upper non-fossiliferous portion at the other end of Hilgard's section.' It is the same formation which Professor Dall calls the 'typical Grand Gulf' in his recent communication, and which he considers Oligocene, and a remnant of the heterogeneous Grand Gulf of Hilgard. We are compelled by the facts to believe that this typical Grand Gulf is not Oligocene at all, but that it belongs about a quarter of a mile vertically above the place in the geological scale to which it is assigned by Professor Dall.

2. There is also no Miocene Grand Gulf, as Langdon's discovery has proved and as has been confirmed by other geologists who have studied the Chattahoochee-Appalachicola section. We might perhaps more correctly say there is no Miocene Grand Gulf below the horizon of the Pascagoula, if that be certainly proved to be Miocene.

3. We think our facts prove that the Grand Gulf, all and singular, occupies a place in the geological column *below* the Lafayette and *above* the Pascagoula (which is the uppermost of the Tertiary formations as yet determined along the Gulf coast). This is all we have endeavored to show, and it was the *raison d'être* of our first note. We do not see wherein what we have there said in any way confirms Professor Dall's 'earlier determinations,' and, furthermore, we think that our view of the age of the Grand Gulf is new, and not a mere equivalent of the views of any other geologist.

EUGENE A. SMITH,
TRUMAN H. ALDRICH.

SHORTER ARTICLES.

THE REMAINS OF BEAR AND DEER ON THE SHORES OF ONONDAGA LAKE.

THROUGH the courtesy of the firm of Will & Bauer, of Syracuse, the university received in March parts of the skulls of six bears (*Ursus americanus*); the leg bones of at least three bears (*Ursus Americanus*); and parts of the leg bones of three deer, the Virginia deer. The bones were identified through the kindness of Dr. Ablen, of the Natural History Museum of New York.

The find was made north of Syracuse, about one eighth of a mile east of Onondaga Lake, while the company was excavating for a trench. The land at this place is level, the surface soil is of a mucky character, varying in thickness from three to nine feet. Beneath the muck there is a bed of marl with here and there some quicksand.

The workmen noticed bones when they first began digging, but failed to bring the fact to the attention of the foreman until the work was nearly completed. A careful watch was maintained during the remainder of the excavations, with the above gratifying results. The bones were not taken from one place, but were found scattered over an area of several square rods, a skull being found at one place and the jaws at another.

A brief description of the bones may be of some general interest. The larger skull measured twelve inches from the occipital ridge to the premaxilla; nine and one half inches from the anterior side of the foramen magnum to the premaxilla; three and one half inches from the right zygomatic arch to the sagittal plane of the skull; the left

zygomatic arch was destroyed. Large portions of the occipital and parietal bones were missing, as if the skull had been crushed in killing; there was no evidence of recent change. The smaller skull was the more complete. The distance from occipital ridge to premaxilla was ten and one half inches; from the foramen magnum to the premaxilla, six and one quarter inches; the zygomatic arches were both broken and there was a hole in the occipital and left parietal, as if the animal had been shot. The complete mandible belonging to this skull was found.

In addition to these two skulls, which are of the black bear, there were parts of four different mandibles of the same variety, one of which was a full inch longer than the mandible of the larger skull. The incisors are present in this large mandible, and a number of rudimentary premolars were found in several of the mandibles.

The leg bones of the bears consist of the following: one pair of humeri ten inches long, incomplete, the proximal ends being absent. These two humeri are so similar that I believe that they belonged to the same animal. One right humerus nine inches long, having the proximal ends present; the distal ends of two left humeri; a left tibia and fibia which are united, and a right tibia that is so similar to the left one that they undoubtedly belonged to the same animal. Judging from the number of humeri, we have at least the remains of three bears and possibly a fourth.

The deer bones are one incomplete humerus and radius, eight and one half and nine and one half inches, respectively, in length, and a complete ulna eleven and five eighths inches long. These three bones articulate perfectly. One tarsal nine inches long, that articulates with the radius and ulna. A second set of leg bones that articulate also, indicating that they are from the same individual. One humerus eight and one half inches long, the proximal end absent; one radius nine and three fourths inches long, complete; one ulna five and one half inches long, incomplete; two broken humeri; three miscellaneous vertebræ; six ribs, and the part of an antler. This would give us the remains of at least two deer.

All these bones are recent and do not show any evidence of mineralization. The two skulls and the mandibles and leg bones of the deer still show evidence of animal oil, being slightly oily to the touch. The leg bones of the bears are drier than the others and the epiphysial joints are plainly evident when present, but in most of them the articular surface is lost.

It is difficult, with the few facts at our command, to estimate the age of these bones. I am inclined to think that they are not very old, possibly a hundred years. Until we possess more bones and know more of the geology of the place, any statement concerning their age must be mere conjecture.

As to the manner in which the bones reached this place, a few suggestions may be made. Onondaga Lake is of glacial origin, like most of the central New York lakes. At each side and south of it, the old valley is filled with glacial débris to a depth of several hundred feet, the present lake beach being some distance from the rock strata that limits the valley. Along the hillsides of the region about Syracuse there is evidence of beaches, showing the limits of the lake in prehistoric times. The place where the bones were exhumed probably represents a part of the lake previous to its last subsidence. From the scattered condition of the bones it is easy to imagine how they may have been washed down from the banks, being possibly the remains of an Indian feast.

The present collection is of sufficient interest to warrant some care in future excavations in the above area. W. M. Smallwood.

Syracuse University,
Zoological Laboratory,
May 1, 1903.

BOTANICAL NOTES.

THE STUDY OF WOOD.

With the rapid increase in interest in all matters pertaining to forestry, so notable in the past few years, there has been a corresponding increase in the number of books devoted to some phase of the subject. The

latest contribution is a volume of about two hundred pages entitled 'The Principal Species of Wood; Their Characteristic Properties,' by Professor Charles H. Snow, of the School of Applied Science of New York University, and published by John Wiley and Sons. In his preface the author says of the book that it is 'a brief, untechnical presentation of general features characterizing economically important species of wood.' This should be understood as implying that the presentation is untechnical from the botanical standpoint only, for it is emphatically a technical book, in so far as it is designed for the use of foresters, engineers, builders and dealers in wood (lumber) of all kinds. It is written for and appeals to men of these classes, and to that extent it is a technical book.

The book opens with an introductory chapter containing such explanations as will make the text more readily understood. Then follow thirty-six sections, each devoted to a group of similar woods, and here each section opens with an introductory statement in regard to the species discussed in it. The treatment of the particular species may be illustrated by that of the white oak, which covers the following topics: Nomenclature (including English and Latin names, as well as the more common synonyms); locality; features of the tree (height, diameter, shape, bark, acorns, leaves); color, grain and appearance of the wood; structure of the wood; representative uses of the wood; weight of seasoned wood (in pounds per cubic foot); modulus of elasticity; modulus of rupture; remarks (the latter general in nature). Each topic is given a paragraph, and each species of wood is given one page, and no more. The book is, therefore, a very handy one for reference, since all that is said about any particular wood is seen at a glance on one page. Thirty-nine excellent 'half-tone' plates add much to the usefulness of the volume. It is not too much to say that this book should find a place in every botanical library, and unless we are much mistaken, it will soon become an indispensable work in the hands of those to whom it appeals more directly, and for whom it was primarily designed.

ANOTHER MOUNTAIN LABORATORY.

For several years the University of Montana has maintained a biological station and laboratory at Flathead Lake, Montana. This year it offers its fifth annual session, and there will be opportunities for study in botany, zoology, entomology, nature study and photography. The work in botany includes field study and collecting, classification, type forms, structure, methods of preservation, etc. A general course in ecology and local plant geography is offered also. The region is one which offers opportunities for work on many botanical problems. The surface of the lake is over four thousand feet above sea level, and is surrounded by mountains reaching an altitude of ten thousand feet. It should attract many students of nature.

SPECIMENS OF FUNGI.

Dr. E. S. Salmon, of Charlton House, Kew, England, the well-known student of the powdery mildews (Erysiphaceæ) desires American students of fungi to procure for him specimens of the fruiting stage of *Erysiphe graminis* occurring on *Poa* and other related grasses. The conidial stage is quite common, but the fruiting stage is less so, and it is the latter alone which Dr. Salmon desires. American collectors should see that he is supplied with an abundance of good material.

Charles E. Bessey.

The University of Nebraska.

SCIENTIFIC NOTES AND NEWS.

The degree of LL.D. was conferred last week on a number of American men of science, as follows: Harvard University, Professor E. C. Pickering, director of the observatory; N. S. Shaler, professor of geology; William James, professor of philosophy. Yale University, William H. Brewer, professor emeritus in the Sheffield Scientific School. Dartmouth College, E. L. Nichols, who has resigned the chair of physics at Dartmouth to accept a similar position at Columbia University; Alfred Thayer Mahan, U.S.N. Amherst College, Frederick J. E. Woodbridge, professor of philosophy in Columbia University, who graduated from Am-

herst College in 1889. Williams College, Dr. Henry S. Pritchett, president of the Massachusetts Institute of Technology; Dr. E. A. Birge, professor of zoology in the University of Wisconsin, who graduated from Williams College in 1873. Wooster University, Dr. J. H. Hyslop, formerly professor of philosophy in Columbia University. The University of Illinois has conferred the degree of Doctor of Engineering on S. W. Stratton, chief of the Bureau of Standards, and on Professor Ira O. Baker, of the university; it has conferred the degree of Doctor of Agriculture on Professor T. F. Hunt, of the Ohio State University.

PRESIDENT IRA REMSEN, of the Johns Hopkins University, gave the commencement address at Mount Holyoke College on June 24.

PROFESSOR JAMES M. CRAFTS has resigned his position as one of the trustees of the Elizabeth Thompson Science Fund, and Professor Theodore W. Richards has been elected to fill the vacancy.

MR. W. W. STOCKBERGER, instructor in botany in Denison University, has resigned to accept a post as special research assistant in the Department of Agriculture, Washington, D. C.

R. S. LEA, who has been professor of civil engineering and lecturer in mathematics in the faculty of applied science at McGill University during the past eleven years, has resigned to devote himself to professional pursuits.

DR. WILFRED NEWSOME STULL has been appointed Carnegie research assistant to Professor Theodore W. Richards, at Harvard University.

THE Stevens' Triennial Prize of Columbia University for original research has been awarded to Drs. L. Pierce Clark and Thomas P. Prout, of New York, for their 'Status Epilepticus: A Clinical and Pathological Study of Epilepsy.'

MME. SKLODOWSKA CURIE has received the degree of Doctor of Science from the University of Paris, her thesis being based on her well-known researches on radio-active substances.

A PRESS despatch from Tacoma reports that the expedition which recently started north on the Fish Commission steamer *Albatross*, under the leadership of Dr. David Starr Jordan, president of Stanford University, has been forced to return after the vessel had reached Fort Rupert on her way to Arctic waters, where conditions of fish and seal life were to have been investigated. The return was due to the discovery of smallpox aboard, the disease afflicting one of the crew. The vessel will be cleaned and fumigated and the party held for observation for nine days.

PROFESSOR CHARLES E. BESSEY, of the University of Nebraska, was given a short leave of absence by the regents of the university at a recent meeting. He intends to sail for Europe early in July, going directly to Germany, where he is to be joined by his son Ernst A. Bessey, and together they are to proceed to southeastern Russia, in the Caucasus region. Here they are to investigate the vegetation on both sides of the mountain range, returning by way of the Black Sea, on whose northern coast they intend to work for some time. Professor Bessey intends to return to America late in the autumn.

W. D. HALLIBURTON, M.D., F.R.S., professor of physiology, King's College, London, has accepted an invitation extended by the faculty of the University and Bellevue Hospital Medical College to deliver a course of twelve lectures on pathological chemistry, beginning on Monday, January 4, and continuing daily until January 16, 1904. The funds are provided from an endowment given by the retiring professor of pathological chemistry, Dr. Christian A. Herter. Dr. Herter has also endowed a research fellowship in pathological chemistry. Mr. Louis C. Tiffany has furnished a fund for a research fellow in physiology for the ensuing year.

CHANGES in the stations and duties of officers of the Signal Service have been ordered as follows: Colonel H. H. C. Dunwoody, relieved from duty at headquarters, Department of the East, and ordered to duty at Fort

Myer, Virginia; Lieutenant-Colonel James Allen, on completion of present duty, will take station in this city as signal officer of the Department of the East; Lieutenant-Colonel Richard E. Thomson is relieved from duty at Fort Myer, and ordered to Vancouver Barracks, Washington, for duty in the Department of the Columbia, in addition to which he will assume charge of the military system in Alaska; Captain George C. Burnell, at Juneau, Alaska, has been ordered to Seattle, Wash., where he will assume charge of the cable system between Puget Sound and Alaska.

Professor William Elder, of the department of chemistry at Colby University, died on June 25. He was born in Nova Scotia about sixty years ago. He graduated at the Provincial Normal School in 1860 and at Acadia College in 1868. The next year he studied at Harvard under Professors Agassiz, Cooke and Shaler. From 1869 to 1873 he was professor of physical sciences at Acadia College. In 1873 he was called to the professorship of chemistry and natural history at Colby University and remained at the head of that double department till 1885, when he became Merrill professor of chemistry.

The United States Civil Service Commission announces that, owing to the small number of applications filed for the examination scheduled for June 29–30 for the position of teacher in the Philippine Service, the examination will be postponed to July 22–23. The salary at first is from $900 to $1,200 with opportunity for advancement. There are now about 850 American teachers in the Philippine service. The subjects of the examination include the ordinary branches taught in normal schools, and optional subjects may be taken, including the sciences. It seems unfortunate, and may perhaps account for the small number of applications, that the result should be based almost exclusively on an elementary written examination, eighteen points being given for this, and only two points for experience, training and fitness.

The International Institute of Sociology holds its fifth congress this year in the Sorbonne, at Paris, from July 6 to 9, under the presidency of Dr. Lester F. Ward, of Washington. The leading subject for discussion will be the relation of Sociology to Psychology. The Institute was founded in 1894 with Sir John Lubbock (Lord Avebury) as its first president. It is thoroughly international and each of the presidents annually chosen represents a different country. Dr. Ward is its first American president. It has published nine volumes of *Annals,* in which a great variety of subjects relating to the social sciences are discussed from a strictly scientific point of view.

A telegram has been received at the Harvard College Observatory from Professor Kreutz, at Kiel, stating that a comet was discovered by Borelly at Marseilles, June 21, 469, G. M. T. in R. A. $21^h\ 52^m\ 52^s$ and Dec. $-8° 10'$. The comet had a daily motion of $-7'$ in R. A. and $+44'$ in Dec. Nucleus and tail were observed.

We learn from the report in the London *Times* that there was a very large audience at the Royal Institution on June 19 to hear Professor Pierre Curie, of the Sorbonne, Paris, lecture on radium. Sir William Crookes was in the chair, and among those present were Mme. Curie, Lord Kelvin, Lord Rayleigh, Lord Avebury, Sir Frederick Bramwell, Sir Oliver Lodge, Professor Dewar, Professor Ray Lankester, Professor Ayrton, Professor S. P. Thompson and Professor Armstrong. Professor Curie, who spoke in French, began with some experiments to illustrate the properties of radium. He showed that it was capable of spontaneously and continuously disengaging heat, that it had the power of rapidly affecting photographic plates even through opaque bodies, and that it could provoke luminous phenomena in phosphorescent substances such as platinocyanide of barium, not losing its power even when cooled to the temperature of liquid air. He next proved its ability to render air a conductor of electricity, by showing that a charged electroscope was at once discharged when a frag-

ment of radium was brought into its vicinity, and in another experiment showed that it facilitated the passage of the electric spark. He went on to describe the different radiations given off by the substance and to distinguish them according to their power of penetration, absorptibility, behavior in a magnetic field, etc. He then explained that, in addition to these radiations, radium also gave off emanations which had the same properties as the substance itself—properties which were included in the term radioactivity. The salts of radium in solution gave off this radioactivity, and were able to render other objects of all sorts radioactive. In this emanation, for example, a charged electroscope was discharged, and a phosphorescent substance became luminous. The emanation behaved in many ways like a gas. It could be aspirated through a tube, it could be condensed by liquid air, and after being frozen out of a vessel would diffuse throughout it again when the temperature was allowed to rise. These phenomena were illustrated by a very pretty experiment, in which a vessel containing a weak solution of radium chloride was connected by a tube to another vessel containing some sulphide of zinc. So long as the stopcock on the tube connecting the two vessels was closed the sulphide of zinc did not phosphoresce, but as soon as it was opened the luminous effect appeared. Returning to the heat disengaged by radium, the lecturer proved the reality of the phenomenon by the aid of what he said was in fact a liquid air calorimeter. A small piece of glass was lowered into a carefully isolated vacuum-flask containing liquid air, and the amount of gas that boiled off in a given time was measured. The experiment was then repeated, but instead of the plain piece of glass a small vessel, identical in size, containing radium was substituted, with the result that in the same time the quantity of gas given off was seen to be more than doubled. Professor Curie concluded with a slight reference to some other properties of radium, its chemical effects, its place in the periodic table of the elements, its power of producing sores on the skin and even of inducing paralysis, and the character of its spectrum. He also gave a brief account of the studies which led Mme. Curie and himself to the recognition of it and other radioactive bodies, and touched on the speculations suggested by the phenomena it presented as to the evolution of matter and the gradual transformation of the elements.

UNIVERSITY AND EDUCATIONAL NEWS.

THE state appropriations for the University of Illinois this year reached the wholly unprecedented sum of $1,260,000. The sum of $150,000 was given for enlarging the engineering equipment. The College of Agriculture received $100,000 for equipment and instructional work, and the experiment station associated with the college received $170,000 for research work. The ordinary operating fund of the university was increased about $100,000 per year which will make this fund about $350,000 per year. The library fund was doubled, being made $20,000 per year. The sum of $80,000 was voted for a Woman's Building. The sum of $14,400 was given for the maintenance of the department of commerce. The smaller appropriations included $10,000 for cabinets, collections, apparatus, etc., and $10,000 for equipping the chemical laboratory.

AT the eighty-sixth commencement of Hamilton College, President Stryker announced a gift of $100,000 in U. S. Steel Corporation bonds from Mr. Andrew Carnegie, in recognition of the public service of Secretary Root, a graduate of Hamilton. Mr. Carnegie has also given $50,000 to Beloit College for a library building.

COLBY COLLEGE has received gifts amounting to $46,000, including $20,000 from the estate of S. S. Smith, D.D., the author of the hymn 'America,' and formerly trustee and professor of the college.

The board of regents have completed arrangements for creating a school of applied science in the State University of Iowa. A professorship in electrical and mechanical engineering was created. Professor C. S.

Magowan was elected professor of municipal and sanitary engineering—that chair being created. He will also be professor in charge of drawing in connection with civil engineering. Professor A. G. Smith was elected professor of mechanics in the department of mathematical engineering.

The board of regents of the State University of Iowa during their recent session passed resolutions instructing the university architect to report plans at the September meeting for the erection of a building designed to give relief to the present crowded condition of the University Museum and Library. The plan which at present seems to meet with most favor is the erection of one wing of a large building that is to be ultimately used for a museum purpose only, but which would in part be used at first also for the accommodation of the general library, department libraries remaining for the time where these now are. The museum would at once obtain permanent quarters as far as the space thus provided would permit. By vacating the third floor of the present science building, through removal of the museum, space would be secured for the better accommodation of the remaining biological departments.

At the annual commencement exercises of the University of Nebraska on June 11, degrees were conferred as follows: Bachelor of Arts, 132; Bachelor of Science, 38; Bachelor of Law, 84; Master of Arts, 6; Doctor of Philosophy, 2. No honorary degrees were conferred. Of the Bachelor of Science, four received the degree on the completion of the course in civil engineering, seven in electrical engineering, and three in mechanical engineering, the remainder having completed the general science course. Of the six Masters of Arts two, George T. Hargitt and Erle M. Stevenson were in zoology, one, Samuel R. Williams, in physics, and one, John W. Hilton, in philosophy. One of the Doctors of Philosophy, John Lewis Sheldon, took the degree in botany.

At the June meeting of the board of trustees of the University of Illinois, the following new appointments were made: Oscar Adolph Leutwiler, assistant professor of machine design; Dwight T. Randall, assistant professor of steam engineering; Banus Hutson Prater, instructor in civil engineering; Amos William Peters, instructor in zoology; John Henri Walton, instructor in chemistry; John James Harman and Robert Hayden Kuss, instructors in mechanical engineering; Lester Abram Waterbury, instructor in civil engineering; William F. Schultz, instructor in physics; Edward O. Heuse and Edna D. Hoff, assistants in chemistry; Emery Roe Hayhurst, assistant in physiology; William S. Bullard, assistant in zoology; Ira Obed Schaub, assistant in chemistry in Experiment Station; Clifford Willis, assistant in soil physics.

Professor Forest R. Jones, of the Worcester Polytechnic Institute of Technology, has received the appointment of professor of machine design at Cornell University.

Professor A. Ross Hill, of the University of Nebraska has been elected professor of philosophy in the University of Missouri, and Professor F. C. French, of Colgate University, has been elected to the chair at the Universty of Nebraska.

Professor A. E. Taylor, M.A., of Owens College, Manchester, has been appointed to the John Frothingham chair of philosophy at McGill University.

A. D. Sorrensen has been appointed associate professor of psychology and moral philosophy at Colby College.

Dr. B. S. Merigold, instructor in industrial chemistry at the Massachusetts Institute of Technology, has been elected assistant professor of chemistry at Clark College.

George A. Hanford, Ph.D. (Yale), will next year have charge of the department of chemistry at the Medical School of Syracuse University.

Mr. Percy Elford has been elected secretary of the Technical Instruction Committee for the county of Oxford, at a salary of £600 a year. He retains his lectureship of chemistry at St. John's College, Oxford.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JULY 10, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE WORK OF THE COAST AND GEODETIC SURVEY.**

IT is a high privilege to address you today on the work of the oldest bureau of applied science under the government, a bureau which invokes the aid of science in its intensely practical work, where theory and practice go hand in hand. It seems reasonable to hope that some inspiration may be drawn from an account of its work, by young men who are about to take up the pleasures and burdens of a share in the world's work after going forth from an educational institution which announces as the underlying principle which controls its method, the advance of the practical, side by side with the scientific. It is particularly pleasant to speak of the survey in a locality where such familiar names as Lovering, Bowditch and Pierce will be recognized as among those who helped it in its earlier struggles for recognition, and that of a statesman like Charles Sumner as one of its staunch supporters, those of Louis and Alexander Agassiz, who utilized the opportunities afforded by the survey to further the aims of science and to add luster to the fame of its work by their association with it, and where it will be remembered that if Massachusetts gave a Peirce to the survey, the survey gave a Mendenhall and a Pritchett to Massachusetts.

* Commencement address delivered before the Worcester Polytechnic Institute.

THE SURVEY'S PLACE UNDER THE GOVERNMENT.

On the first day of next month the Coast and Geodetic Survey will be transferred from the Treasury Department, of which it has been a bureau since 1836, to the newly created Department of Commerce and Labor. This is in accordance with the logic of events. As long as the fiscal department of the government was charged with matters pertaining to commerce the survey found a proper place there, but when the new department was created with functions especially designed to care for the interests of commerce, the survey, being primarily devoted to the interests of commerce, necessarily became a part of it.

The Coast and Geodetic Survey is charged with the survey of the coasts of the United States, including Alaska, and all coasts under the jurisdiction of the United States; the survey of rivers to the head of tide-water ship navigation; deep-sea soundings; temperature and current observations throughout the Gulf Stream and Japan Stream flowing off these coasts; tidal observations, magnetic observations and gravity research; determinations of heights by geodetic leveling, and of geographical positions by lines of transcontinental triangulation which, with other connecting triangulations and observations for latitude, longitude and azimuth, furnish points of reference for state surveys and connect the work on the Atlantic with that on the Pacific coast.

The results of the survey are published in the form of annual reports, which include professional papers of value; bulletins, which give information deemed important for immediate publication; notices to mariners showing changes on charts and reported dangers affecting them; tide tables issued annually in advance; charts upon various scales, including harbor charts, general charts of the coasts and sailing charts, chart catalogues and coast pilots.

ITS GEOGRAPHICAL DOMAIN.

Such in general are its present duties, but when the survey was first planned the coasts under contemplation extended only from the eastern boundary of Maine to the northern boundary of Florida, and on the Gulf coast the shores of the Louisiana Purchase marked the limits of the survey's authority; later on its duties were extended to keep pace with the expansion of the country to the Floridas and the whole of our present Gulf coast, to Oregon and California, to Alaska, and still more recently to the Hawaiian Islands, to Porto Rico and to the Philippines. With the acquisition of Oregon and California and the prosecution of surveys of their coasts arose the necessity for a trigonometric connection between the work on the Atlantic and Pacific coasts, and Congress authorized the extension of the triangulation inland for that purpose, and for the purpose of aiding topographic and state surveys.

The acquisition of the vast territory of Alaska added greatly to the duties of the survey. Beginning at the historical parallel of fifty-four forty, which the popular cry of 'fifty-four forty or fight' demanded as the northern limit of our Pacific coast possessions, the coast of Alaska stretches northward, including the great archipelago which ends at Cape Spencer. Northward of that is Yakutat Bay and Prince William Sound. The latter is assuming commercial importance and is, therefore, now the locality in which the survey is especially active. Farther north is Cook's Inlet, a great bay where the phenomenal rise of the tide, which yet remains to be investigated, rivals or exceeds that of the Bay of Fundy.

North of the Alaskan peninsula the Kuskowim River empties into the Bering

Sea. This large river has its head waters at the base of Mt. McKinley, the highest mountain on our continent, and among Alaskan rivers is second only to the mighty Yukon, whose desolate delta the survey has already charted. No matter how inhospitable the shores, how rugged and forbidding, they will not challenge in vain the skill and daring of our surveyors, as was foretold by Charles Sumner in his speech in favor of the acquisition of Alaska, in which he alluded to the Coast Survey as follows: "An object of immediate practical interest will be the survey of the extended and indented coast by our officers, bringing it all within the domain of science, and assuring to navigation much needed assistance, while the republic is honored by a continuation of national charts, where execution vies with science and the art of engraving is the beautiful handmaid."

The Aleutian Islands, with their towering volcanoes and rugged and bold coasts, stretch westward for twelve hundred miles from the Alaskan peninsula and need yet to be accurately charted. This chain of islands lies along the shortest route from Puget Sound to the Philippines, a route which has already been followed by a ship of the survey in transferring its activities from the sub-arctic waters of Bering Sea to the tropical waters of the Philippines.

In this new domain the survey has another extensive field of operations. For in general the surveys which were made prior to the coming of the Americans are lacking in accuracy and reliability, and are not at all suited to meet the wants of an active commerce. The Philippine archipelago stretches northward from about latitude 5° to 21° and through about ten degrees of longitude, and the intricate shore line of its islands surpasses in length that of the United States proper. Our Samoan island possessions and Guam remain to be surveyed, but in the Hawaiian Islands the most needful work has been accomplished. The size of the Philippines will be better understood by comparison with an island with which we are reasonably familiar. Five islands in the Philippines are as large or larger than Porto Rico, and two of these each about ten times as large.

To Porto Rico the survey promptly extended its work, for, almost before the smoke of battle had cleared away, Admiral Sampson called for accurate surveys of the coasts of Porto Rico in a telegram addressed to the Secretary of the Navy, who requested the survey to begin the charting of its coasts. The work was at once inaugurated, with surprising results. Harbors which had been unknown to the cartographer were discovered, surveyed and mapped. A triangulation was extended around the island and as far eastward as the Danish island of St. Thomas, across the Virgin Passage, famous as the principal entrance into the Caribbean Sea, and near which lies the winter rendezvous of our navy. All the principal harbors have been charted and the results given to the world. One of the interesting results of these surveys is that cartographically the northern shore of the island was moved southward half a mile and the southern shore northward by the same amount. The cause of this is that the visible island of Porto Rico is really the summit of a mountain whose slopes extend to great depths below the adjacent seas. The results of observations for latitude made on the north and south sides of this summit are affected by local attractions of mountain masses which cause deflections of the plumb line and which must be taken into account in charting the island.

ITS GEODETIC FUNCTION.

When the inauguration of the survey was under discussion at the beginning of the

century it was held an open question by some whether the work should be coordinated by purely astronomical observations or whether it should be based on a trigonometric survey, and happily the latter method was chosen and prescribed.

From carefully measured bases chains of triangles were to be extended along the coasts. Their direction and geographical location were to be determined by astronomical observations. The skeleton of triangles was to be clothed by the topographer, who should delineate the topographic features as far as might be necessary for commerce and defense. By making proper use of the trigonometric and topographic features thus determined the hydrographer would follow and sound the depths of the waters, develop the channels fit for safe navigation, discover all hidden dangers, measure the tides and the currents, and thus furnish what was needful for a safe chart. As a matter of fact, this sequence of work, though it is of necessity observed in local surveys, was never followed when the Coast Survey as a whole is considered. The rapid commercial development of this country made it necessary to meet particular demands in some localities at once, leaving others of lesser urgency to be dealt with later on, but the general scheme of proper coordination by a principal triangulation was never lost sight of, though the latter oftentimes followed long after the local surveys had been made. This experience is being repeated in Alaska and particularly in the Philippine Islands, where the survey is constrained by the needs of commerce to make surveys here and there, wherever routes of travel or anchorages have to be developed, leaving it to the future progress of the survey to coordinate all this work.

The distances of the stars, the sun and the moon from the earth as we know them have all been measured, to use the language of a former astronomer royal of England, by means of a yard-stick. For the purpose of this illustration it is immaterial that the particular yard-stick of this survey is the meter. The point is that with a short bar we measure a relatively long base, from this we extend a triangulation over relatively much longer distances, from these distances we deduce the size of the earth and its diameters and thus have found the basis of all dimensional astronomy. The triangulation of the Coast and Geodetic Survey, therefore, subserved not only its immediate purpose of serving as a basis for accurate charting of the coasts, but contributed by its great extension to a knowledge of the earth's dimensions and figure, a problem which has occupied the mind of man since Eratosthenes, 300 B.C., to the present time. For the survey has completed a triangulation from Eastport, Maine, to New Orleans, Louisiana, a distance of 2,400 kilometers, and another from Cape May to San Francisco along the 39th parallel, a distance of over 4,000 kilometers. It is just now engaged in extending another great chain of triangles, which has been measured between the southern boundary of California and a point beyond San Francisco, towards Puget Sound, where in turn it will be connected with our northern boundary. Along the 98th meridian also a chain of triangles is being measured, and it is hoped that the Republic of Mexico on the south and Canada on the north will prolong its measurement through their respective domains. Branching from this meridian a line will cross to the eastward to connect with the admirable triangulation of the Lake Survey which has already been connected with the primary triangulation of the Coast and Geodetic Survey in other places.

The great triangulation already com-

pleted has been adopted as a standard of reference for all future trigonometric work of the survey in so far as purely geographic and topographic purposes are concerned and this great country will soon have a homogeneous system of geographical coordinates which will serve, it may be confidently believed, for all times to come, the manifold uses to which it can be put by the national government, by the states and municipalities and by engineers and surveyors.

Intimately connected with the question of the dimension of the earth is that of its figure, and here the pendulum will play an important part. The earlier work of the survey with the pendulum has its chief value in showing the limitations of the methods and appliances used. Much simpler and more reliable apparatus was introduced some years ago and has given satisfactory results. The apparatus was used not only in relative gravity observations in this country but for the purpose of connecting our own base station with the English and continental ones, a work which was rendered possible by a subvention from the International Geodetic Association. At the present time no gravity work is being done, it being deemed advisable to study the deflections of the plumb line as brought out by a reduction of the triangulation to a common system. When that has been done the pendulum may perhaps serve to indicate relations between any anomalies that may develop in particular localities and the force of gravity in the same regions.

Closely related to these geodetic features of the work of the Coast Survey are the astronomical determinations and especially the determinations of telegraphic longitudes. Long ago the survey determined the difference of longitude between Europe and this country by means of the Atlantic cable. It has covered this country with a well-adjusted network of stations and is now stretching its determinations westward across the Pacific. The longitude between San Francisco and Honolulu is being determined while we are gathered in this hall, and the observers are getting ready to meet the new cable at Guam within a few weeks in order to extend the work to Manila. Manila has been the base station for our observers in the Philippines, who have been for two years busily engaged in utilizing the local cables and land telegraph lines for similar purposes. The geographic explorations in Alaska, the boundary question and the surveys in that territory call for further and immediate extension of this work there. But it requires no great stretch of the imagination to believe that the wireless method of sending signals will at no distant day make us independent of cable or telegraph lines as far as longitude work is concerned, and for this purpose the method would be an ideal one. Last summer, as an experiment and with short-distance instruments, a chronometer on one of the survey vessels transmitted automatically its half-second beats to a shore station over sixty miles away, where they were received and automatically recorded on a moving tape.

In the leveling of precision we have still another class of work belonging to the geodetic function of the survey. Here the aim of the survey is to furnish a series of primary bench marks properly related to the mean sea level of the Atlantic, Gulf and Pacific coasts which shall serve to correlate the thousands of miles of levels which have been and are being run by the railways, the canal enterprises, the Geological Survey and the engineers of the United States Army for many different purposes, but all for the common good. It is pleasant to record that through the cooperation

of the other government surveys concerned, their results are all being placed at the disposal of this bureau for the purpose of including them in a general adjustment by which a homogeneous system of vertical coordinates for the whole country can be established which shall stand side by side with geographical coordinates before referred to.

THE DATA FOR A CHART.

The geodetic functions of the survey have been dwelt upon in this address at some length because their precise nature and great usefulness are not commonly understood, but the administration of the survey has always remembered that the survey owes its existence to the urgent need for reliable charts of the coasts. Their importance to commerce is apparent. The vast sums which every civilized nation is expending in improving its facilities for commercial intercourse are sufficient evidence that everything which can be done to promote the safety of navigation must be done. Every civilized nation also recognizes the fact that this is a duty which it owes not only to its own citizens, but to the world. As an evidence of this consider the lighthouses which flash their friendly warnings or guiding welcome to ships in all parts of the world, the buoys which mark dangers along channels, the sounding sirens which cry their caution through the fogs, the storm signals which are displayed, the sturdy life-savers who patrol the coasts and the guiding charts with which this survey is mainly concerned.

On the open ocean the chart has its least value, for the dangers to which the mariner is there exposed are not such as can be remedied by a chart. Storms, fogs and collision with other ships in the lanes of travel are dangers to be apprehended, but the knowledge that there is deep water under the keel of the ship is a source of comfort to the mariner, however risky it may appear to the landsman. The story of the darky who compared the dangers of a sea voyage with the safety of railway travel is familiar to all: "If the ship sinks whar is yo, but if the train gits smashed dar yo is," illustrates one point of view, but that of the sailor is told in rhyme which the refined muse of the Worcester Polytechnic may not know and is therefore cited here:

> Foolhardy chaps as lives in towns,
>   What danger they are all in,
> And now lie quaking in their beds
>   For fear the roof should fall in.
>
> Poor creatures, how they envies us,
>   And wishes, I've a notion,
> For our good luck, on such a night
>   To be upon the ocean.
>
> * * * * * * *
>
> While you and I, Bill, on the deck
>   Are comfortably lying,
> My eyes! what tiles and chimney-pots
>   About their heads are flying.

But when the ship nears the coast a burden of great responsibility rests upon the navigator, for on his skill, experience and knowledge the safety of life and property entrusted to his care depends. He turns to the chart and follows the path marked out for him by the skill of the surveyor. When the depth of water is great as compared with the draft of vessels, the problem of the hydrographer is comparatively simple, but where it decreases so as to exceed not very much the draft of vessels, the problem of finding every hidden rock, every coral pinnacle or shoal, requires an immense amount of work and minute accuracy in the soundings and locations. Imagine to yourselves a totally submerged city and solve the problem of finding every chimney, every steeple, every house top and every street by means of a sounding lead, and you will have a good illustration, even though it be a slightly exaggerated one,

of the difficulty of making an accurate hydrographic survey in regions where the coral rocks rise in pinnacles from relatively great depths with appalling suddenness. As a concrete example take a small area about 400 square miles lying between Porto Rico and St. Thomas, a region used by our fleet for its maneuvers, and consider what it means to find with the lead every hidden coral rock or reef which might cause the destruction of a seven-million-dollar battleship.

Not only must the depths be correctly shown, but as a further aid to navigation the characteristics of the bottom must be indicated, and there are places on the Atlantic coast where the nature of the bottom, as disclosed by the material which is brought up by the sounding-lead, is so characteristic of the particular locality that it tells the navigator the exact position of his ship.

When the triangulation and topography are complete, and the channels and general configuration of the bottom have been developed and charted in their true relation to the natural or artificial objects on shore which guide the navigator, yet is the chart not complete. The rise and fall of the tide as affecting the indications of the chart must be known at any time in present and future. To the difficult problem of the tides the survey has also addressed itself, and permanent stations are maintained which record automatically the stages of the tide. The information furnished by them is supplemented by shorter series of observations made at intermediate places by our own surveying parties or by others. The commerce of this country, however, knows no geographical boundaries, and the survey collects and publishes annually in advance a volume giving predictions for nearly all the ports of the world.

Another branch of the survey which covers a broad field of observation and research is that of terrestrial magnetism, represented on the chart by compass diagrams. In order to draw them correctly and by means of them to show the amount of the variation of the needle at given localities, the magnetic elements have been investigated from the earliest days of the survey. At first these investigations were inaugurated in the interests of the mariner alone, and confined to the neighborhood of the coasts, but as years passed the demands made on the survey for more information required their extension to the whole area of the United States and beyond. The intimate relation of the compass to property surveys is the chief case in point. The rerunning of the boundaries of old estates, the interpretation of old deeds in litigation, require a knowledge of the amount of the needle's variation in the present time and the means of computing its direction in the past. In the more delicate work of the electrical engineer the earth's magnetic elements have also to be taken into consideration. Side by side with the practical requirements the scientific phase of the subject has been kept in view, with full faith in the belief, which is based on the history of science, that the things which to-day are speculative and abstruse will to-morrow belong to the commonplace applications of science to the daily wants of the community. The survey now maintains a small magnetic observatory in Porto Rico; a complete and modern one at Cheltenham, Maryland; another at Baldwin, Kansas; one at Sitka, Alaska; and yet another near Honolulu in the Hawaiian Islands. We may hope, therefore, that the United States will contribute no small share towards finding the mysterious cause of the earth's magnetism, or at least in furnishing the data necessary for a more

perfect understanding of the laws which govern its manifestations.

How the information gathered by the various branches of the field work is utilized in the office and prepared for publication belongs to another chapter which can not be read to-day. Nor will time permit a reference to the mechanism of its organization. What the survey is and does is due to the men who composed its working force in the past and who compose it in the present, and, therefore, this fragmentary account may be fitly closed with a brief reference to the men who carry out its field work.

While there is a proper amount of specialization which leads to excellence in particular branches of work, the field officers hold themselves in readiness to perform any kind of duty which may be required of them. It may be to pack a mule train or to command a ship, to pitch a camp or outfit a vessel, to sound along the edge of resistless breakers, to climb glaciers or to break through tropical jungles, to guide vessels through uncharted dangers or men along a mountain trail, to look after the health of their men in all climates, to provide months in advance for supplying them with food in regions where none can be purchased, to build structures which shall tower over tall trees of the western forests in order to see distant stations, to observe the stars by night, to watch the swinging pendulum for the determination of gravity, to measure the forces of the earth's magnetism, to note the tides and currents, to sound the waters of the ocean, to map the topography of the land, to trace international or state boundaries, to cover the land with a network of triangulation, or to join their no less zealous co-workers in the office in the reduction and discussion of results. Long as this recital of their occupation may seem, it is but a tithe of what might be said. Surely the merest contemplation of these duties shows how high the calling of the men who must perform them, and if high thinking and plain living and a life of deeds are things which deserve admiration, they earn it day and night, year in and year out.

Perhaps the zeal and devotion to duty is born in part of the difficulties which men must overcome in the accomplishment of a great purpose. But to whatever it is due, it appears to be common to the craft, as appears from the tribute paid to the British surveyors by the historian of the Great Trigonometrical Survey of India, a tribute which is cited here for the glory of the engineering profession.

"It is and has been a very noble band, that body of surveyors who have been trained and have worked under Lambton, Everest, Waugh and Walker. It is no small honor to be at their head. These men must combine the knowledge and habits of thought of a Cambridge wrangler with the energy, resource and presence of mind of an explorer or backwoodsman, and they must add to this the gallantry and devotion which inspire the leaders of a forlorn hope. The danger of service in the jungles and swamps of India, with the attendant anxiety and incessant work, is greater than that encountered on a battle-field; the percentage of deaths is larger, while the sort of courage that is required is of a far higher order. The story of the Great Trigonometric Survey when fitly told will form one of the proudest pages in the history of English domination in the East."

Is there anything which can stir the blood more than this reference to the fierce conquest of great difficulties in order to achieve a high purpose, or anything more ennobling than the contemplation of unselfish devotion to duty?

O. H. Tittmann.
U. S. Coast and Geodetic Survey.

RECENT DEVELOPMENTS IN THE STUDY OF RADIOACTIVE SUBSTANCES.*

Barely eight years have elapsed since the discovery of Becquerel rays. Yet during that time the subject of radioactivity has developed so rapidly that it has now become an important branch of physics and chemistry. The phenomena are interesting in themselves, in some cases almost startling. But even more important is the bearing of the results upon some of the conceptions that lie at the very foundation of physical science. The study of radioactivity seems destined to exert a profound influence upon physical and chemical theories.

Without entering into the history of the subject, I shall first call attention to the results that are now best established, putting the facts into as systematic form as possible. The contradictory character of the early work, and the great complexity of the phenomena themselves, make this as difficult as it is desirable.

A radioactive substance may be defined as a substance which sends out Becquerel rays; *i. e.*, rays that are capable of penetrating bodies usually regarded as opaque, and which produce certain characteristic photographic and electric effects. In their general behavior such rays show a close resemblance to Roentgen rays; the differences will be referred to later. In the table below is given a list of the radioactive substances now known.

Radioactive Substances.

Permanently Active.

Uranium ....(238)
Thorium ....(232)
Radium ....(225†)

Polonium......... (radioactive bismuth)
Actinium.
Radioactive lead.

Temporarily Active.

Ur–X, Th–X, excited activity obtained from air, from freshly fallen rain or snow, or from permanently active bodies.

It will be noticed that the list is divided into three groups. The first, containing uranium, thorium and radium, consists of elements whose separate existence is well established. This statement may now be made in the case of radium as well as in the case of the other two, since this substance has recently been so completely isolated as to make possible the determination of its atomic weight, while it has been shown by several observers to possess a characteristic spectrum. It will be noticed that the elements in this radioactive group possess atomic weights greater than any other known elements.

The second group is made up of suspected new elements. These elements have not been isolated and have not yet been found to give characteristic spectra. It is thought by some that the radioactivity in these cases is due to the presence of a trace of radium—so small as not to be detected by an ordinary test. It appears to me that the arguments against this view are strong. But the question can only be settled by more extended experimental study.

In the case of the substances of the first two groups, with the possible exception of polonium, the radioactivity is permanent so far as our present knowledge goes. In other words, these substances continue to give out Becquerel rays without special stimulation, such as is required for ordinary phosphorescence, and with no diminution in intensity that has thus far been detected. The question as to whether any

* Address delivered before the Cornell Section of the American Chemical Society on May 18, 1903.

† A study of the spectrum of radium has led Runge and Precht to assign to this new element the atomic weight 25.8 instead of the value 22.5 obtained by Madame Curie by chemical methods. Some uncertainty therefore still exists.

substances are permanently active in a strict sense is not to be regarded as settled. I think, however, that most physicists feel that all active substances must gradually lose their activity, even though the rate of loss is too small to have been yet detected.

A third group of substances contains those which possess temporary activity, lasting for a period ranging from a few minutes to several months. Temporary activity may be acquired in a large number of ways. It may be obtained from the atmosphere, from freshly fallen rain or snow, from certain products developed by chemical processes from other active substances, and in a variety of other ways.

In dealing with the effects of the rays produced by radioactive substances we may conveniently adopt the classification shown in the list given below.

Effects of Becquerel Rays.

Photographic action.

Electric effects. (The most important of these is the power possessed by the rays of making air and other gases temporarily conducting.)

Luminous effects. (Fluorescence produced by the rays in various substances.)

Chemical effects. (Development of ozone, color changes produced in glass, etc.)

Physiological effects. (Burns produced by long exposure to the rays; sensation of light produced by highly active preparations held near the eye.)

Like Roentgen rays, the rays sent out by radioactive substances do not show regular reflection or refraction.

It will be noticed that practically all of the effects produced by Becquerel rays are also produced by X-rays. It would be natural to conclude that the rays are of the same type. Yet there are enough differences in the properties of the two rays to show that this can not be true. For example, Becquerel rays are deflected by a magnetic field and by an electric field and carry an electric charge. X-rays possess none of these properties. It is probable that a radioactive substance sends out *some* X-rays; but the bulk of the rays emitted by it are of a different kind.

The methods used in studying Becquerel rays are naturally based upon the various effects which these rays produce. Up to the present time the photographic effect and the electrical effect have been the ones chiefly employed in the study of the rays. Of the two the electrical method is capable of far greater sensitiveness. In brief, this method is applied in the following way: An insulated conductor of small capacity is connected with a sensitive electrometer and is then charged to a potential of one to two hundred volts. This conductor is placed in a metallic vessel whose walls are grounded. With good insulation the conductor will hold its charge under ordinary circumstances for a long period; but if Becquerel rays are allowed to enter the vessel they make the air a conductor and thus permit the charge to escape. The rate at which the charge escapes, as indicated by the electrometer, is a measure of the intensity of the rays.

In the early study of the subject different observers often obtained contradictory results. In many cases the contradictions have since been explained by the fact that some used the photographic method while others used the electrical method. The two methods of measuring the intensity of the rays do not agree. For example, a substance A may produce very strong photographic effects, while another substance B, also tested photographically, is found to give out rays that are relatively weak. But if the two substances are compared by means of the electrical effects which they produce, it may turn out that B is more active than A.

Results such as this have led to the conclusion that there are different kinds of

Becquerel rays, some of which produce strong photographic effects, while others, not so strong photographically, produce intense electrical effects. More recently it has been found not only that the rays from different substances differ, but that a single substance sends out rays of widely different properties. Three types of Becquerel rays have thus far been recognized. An active substance in general sends out all three kinds, but the distribution of the radiation among the different types depends on the substance. For convenience these rays have been referred to as the α, β and γ rays. A brief statement of more important properties of each kind of ray is given in the accompanying table.

DIFFERENT TYPES OF RAYS.

α Rays.

Readily absorbed (*e. g.*, by a thin sheet of aluminium foil, or even by a few centimeters of air).

Relatively strong electrically, *i. e.*, in making gases conducting.

Photographic effect small.

Behavior in an electric field and in magnetic field such as to indicate that these rays are positively charged particles of molecular dimensions moving at a speed of about 10^9 cm./sec.

β Rays.

Quite penetrating (*e. g.*, pass through several millimeters of aluminium or glass).

Electrical effects weak.

Photographic effects relatively strong.

Carry a negative charge.

Probably consist of negatively charged particles, much smaller than atoms, moving at a speed nearly equal to the speed of light, *i. e.*, 3.10^{10} cm./sec. Behavior in electric and magnetic field consistent with this view.

γ Rays.

Highly penetrating. Pass through several centimeters of metal.

Probably Roentgen rays.

The existence of these different kinds of rays may be proved and their separation may be effected in a number of different ways. The most obvious way is by means of absorption. For example, a layer of aluminium foil will absorb practically all of the α rays, while it permits the β rays to pass with scarcely any diminution in intensity. To separate the β rays from the γ rays by absorption is more difficult, for both of these rays are highly penetrating. Separation may here be effected, however, by passing the rays through a magnetic field, since the β rays are deflected, while the γ rays are not.

Let us consider first the β rays. Practically all physicists now agree in regarding these rays as consisting of very small negatively charged particles, or electrons, moving at great speed. That they carry a negative charge has been shown by direct experiment. It is also an experimental fact that these rays are deviated in a magnetic field, and in an electric field in the manner that would be expected if they were charged particles in motion. But the quantitative relations are such as to indicate that if this hypothesis is correct the mass of each particle must be much less than the mass of the smallest atom, while the speed of the particles must be nearly the speed of light. Each of these statements seems so incredible and revolutionary that it is difficult to accept the hypothesis, even in spite of its complete agreement with experiment at every point where a test can be applied. I think that the difficulty in accepting this hypothesis is probably greater in the minds of chemists than it is with physicists. The battle over the electron theory in its purely physical aspects had already been fought out during the development of the theory of kathode rays.* The behavior of the β rays is so similar to that of kathode rays,

* The development of this subject has been traced by the writer in an article on 'Kathode Rays and some Related Phenomena,' SCIENCE, Vol. XII., p. 41, 1900.

that the electron theory, which has now been universally accepted in the case of the kathode rays, has naturally been extended to include the Becquerel rays.

Until recently the α rays were supposed to be undeflected in passing through a magnetic field. Within the last few months, however, it has been shown both by Rutherford and Becquerel that these rays do experience a deflection. This deflection is in the opposite direction from that experienced by the β rays, and is much less in amount. An extremely strong field is necessary to show the deflection at all. This behavior of α rays is explained by assuming the rays to consist of positively charged particles moving at high speeds. It appears, however, that the particles are much larger, that the speed of these rays, instead of being nearly that of light, is only about one tenth as great.

The third type of rays, the γ rays, has been only slightly studied; but so far as investigation has proceeded the properties of the γ rays are the same as those of X-rays. These rays are highly penetrating and have been found to pass through several centimeters of metal.

The intensity of the rays from radium is much greater than that of the rays from the other active substances. Nearly pure radium preparations have been made which show an activity, as measured by the electrical effect, five hundred thousand times as great as the activity of metallic uranium. Small traces of radium in minerals thus add greatly to the activity of these minerals, even when the amount present is so small that no chemical test can detect it. The electrical and photographic methods of testing for radioactivity are, in fact, more sensitive than any chemical or spectroscopic tests yet discovered.

The great difference between the activity of radium and that of the other active substances, and the fact that small traces of radium are hard to detect, has led to the thought that the activity of other substances might be due to the presence as an impurity of some highly active element, possibly radium itself. In the case of uranium it seemed for a time as though this view was definitely confirmed. Upon precipitating a solution of uranium by ammonium carbonate Crookes succeeded in separating uranium into two parts, one of which was redissolved by excess of the reagent, while the other remained behind as a precipitate. Only a trace of the latter was obtained, but it was many times more active than the original uranium. In fact, when tested by photographic methods this uranium-X, as it is called, seemed to have *all* of the original activity, while the ordinary uranium was no longer active. It was found, however, that the uranium-X soon lost its activity, falling to one half its original strength in about twenty-two days; while the ordinary uranium gradually recovered its activity, regaining one half of its original strength in about the same length of time.

The investigation which led to the separation of uranium-X illustrates the contradictions which may arise in work of this kind. Crookes used the photographic method and obtained the results just stated. Others, repeating his work by the electrical method, reached very different conclusions. When tested electrically the increased activity of Ur-X was not nearly so marked, while the ordinary uranium was nearly as active as ever. The separation is now seen to be one which divides the active uranium into two parts, both of which are active; but one part gives out α rays, while the other gives chiefly β rays. A similar separation has been effected in the case of thorium. In this case thorium nitrate is precipitated

from solution by ammonium hydrate. The filtrate, which is free from thorium, when evaporated to dryness shows an activity measured electrically fully one thousand times as great as that of the original thorium. Thorium-X, like Ur-X, is present as a trace only. Its radiation consists chiefly of β rays. But both thorium and Th-X develop rays of both kinds.

It was early found that both thorium and radium possess the power of exciting temporary activity in bodies placed near them. This excited activity may also be produced by bringing air that has been in contact with radium or thorium past the body to be excited. The results are explained by the fact that thorium and radium each give out an 'emanation,' which behaves in all respects like an inert gas. This emanation is itself radioactive, as may be shown by the electrical effects produced by it, and it also has the power of exciting temporary activity in bodies with which it comes in contact. The emanations lose their activity rather rapidly; in the case of thorium the activity falls to one half its original value in about one minute, while in the case of radium a similar loss occurs in the course of several days. Radium and thorium are the only substances that give emanations; they are also the only substances which have the power of exciting activity in neighboring bodies.

That the emanations of radium and thorium are gases is confirmed in a great variety of ways. For example, they can be occluded by porous solids, such as the solid salts which develop them. Owing to the fact that the radium emanation preserves its activity for a long time, the occlusion of this emanation is more readily studied. A large part of emanation developed by radium is occluded by the radium salt itself; this may be driven off by heating, after which considerable time is required for the original condition to be restored. When the active salts of radium or thorium are in solution the emanations developed are liberated more rapidly, there being in this case no chance for occlusion. The rate at which the emanation is developed appears to be constant under all conditions.

The emanations of both radium and thorium are chemically inert. They may be passed through sulphuric acid, nitric acid and hydrochloric acid without change, and are also unaffected by passing over red-hot lead chromate or magnesium. They may be condensed, however, by passing through a tube immersed in liquid air. The radium emanation condenses at —150° C., and that of thorium at about —120° C. The rate of decay of the emanation is unaffected by this low temperature. When the temperature is raised again the emanations are liberated with an activity depending only upon the time that has elapsed since they were developed.

The excited activity produced by the emanations of radium and thorium is greatest on bodies that are negatively charged. It would seem, therefore, that the substance to which excited activity is due must itself be positively charged. If the substance is sending out more β rays than α rays such a positive charge would naturally follow.

Temporary activity may be acquired by exposing a negatively charged body to ordinary air. Apparently the atmosphere contains a radioactive gas similar to the emanations mentioned above. This view is strengthened by the fact that freshly fallen rain and snow possess temporary activity, probably obtained from the air. Air from cellars and air that has been drawn from a porous soil are especially rich in this active constituent. J. J.

Thomson has recently found that the water from certain deep wells in Cambridge also contains a radioactive gas.

Several general points brought out in recent years should not be lost sight of, since their bearing upon the theory of the subject seems to be important.

Radioactivity seems to be unaffected by temperature. Neither the activity of a substance nor the rate of decay in the case of temporary activity is affected by a change of temperature as great as that from liquid air to a white heat. None of the physical agencies which usually affect physical phenomena seems to influence radioactivity. These facts, together with the fact that the salts of the active elements are active as well as the elements themselves, have suggested the thought that the phenomena of radioactivity are phenomena of the atom rather than of the molecule.

There are many indications that radioactivity is accompanied by some change in the active substances. For example, the Th-X may be removed from thorium completely; but at the end of a month or so the thorium may be again treated in the same way and as much Th-X obtained as before. It seems as though the development of Th-X was proceeding slowly all the time. The Th-X must itself be undergoing some change, since its activity diminishes steadily from the time of its separation. Further evidences of change are furnished by the continual development of the emanations of thorium and radium and the gradual decay of the activity possessed by these emanations.

Two questions of the greatest importance at once suggest themselves in the consideration of radioactive substances. First of all, if the rays consist of particles shot off from the substances it would seem as though a diminution in weight should result. It seems hardly probable that matter could be gathered in from the surroundings to supply this loss. There is in fact some experimental evidence that strong active preparations lose in weight by a measurable amount; but this evidence is not yet to be regarded as conclusive. Observations to test this point are difficult. The change to be expected is extremely minute, even with the most active substances, and might easily be masked by the results of chemical changes produced by the rays in the walls of the containing vessel. But although the question must be regarded as unsettled, I think that most students of the subject are convinced that a loss of weight actually occurs, even though it has not as yet been detected.

A question of even more fundamental importance, and one that is now attracting especial interest, is that of the source of the energy which the rays possess. It has recently been shown by the Curies that one gram of an active radium preparation develops each hour forty calories of energy. In other words, a gram of this preparation could melt its own weight of ice in two hours. Expressed in a different form, this would mean that this salt of radium develops, in the course of a month, as much energy as is liberated by the combustion of an equal mass of hydrogen. When hydrogen is burned its store of energy is exhausted; but radium can apparently continue to give out this energy month after month, with no diminution in intensity which has yet been detected. The numerical results obtained by the Curies may require correction in the light of more accurate measurements; but the difficulty will still remain. How is it possible for a radioactive substance to continue radiating energy for an indefinite period without appreciable loss?

Several explanations have been suggested.

It has been thought, for example, that radioactive substances may have the power of absorbing the energy of certain rays, hitherto undetected, which are all the while proceeding through space, coming perhaps from the sun. The radioactive substances might utilize the energy thus absorbed in the development of Becquerel rays, just as fluorescent substances utilize the energy absorbed from sunlight in producing luminescent phenomena. This view, I believe, is supported by the Curies. Sir Wm. Crookes has suggested that radioactive substances possess the power of utilizing the energy of surrounding bodies. Such an explanation might possibly contradict the second law of thermodynamics; yet, since the process is not a cyclic one, I do not believe that any contradiction would be found. An objection to this explanation has been raised, based on the fact that radioactivity continues when the substance is placed in a vacuum. Crookes replies, however, that the best vacuum ever obtained contains millions of molecules per cubic centimeter, so that enough are left to supply the energy needed. A test might be applied, as suggested by J. J. Thomson, by placing the active substance in an ice calorimeter entirely surrounded by ice. If the ice melts, as is probable, it would seem that the Crookes explanation could not hold.

Elster and Geitel suggested, a few years ago, that the energy might be derived from processes of molecular or atomic change which accompany the development of Becquerel rays. According to this view, an active substance is one which is slowly changing from an unstable condition into a more permanent form; the processes which go on during this change may bring about the development of Becquerel rays, while the energy developed is that liberated during the transition. The production of Th-X from Th is perhaps the first stage in such a change; the decay in the activity of the Th-X and the production of the emanation, perhaps form the second stage; while a third step in the progressive alteration of the original substance is shown by the development of excited activity from the emanation. The final products of this disintegration process are doubtless much simpler in their structure than the original substance, and are probably not radioactive. It has been suggested that helium, which has so far been obtained only from radioactive minerals, may be one of the final products of radioactive change.

Perhaps the most serious difficulty in accepting the explanation just mentioned arises from the large quantities of energy involved. It seems almost incredible that so much energy could be stored in a few milligrams of material. The changes assumed are, however, atomic changes. May it not be that such changes involve energy quantities of a higher order? As we proceed from the ordinary motions of mass mechanics toward motions of a finer grain the energy involved increases. A falling raindrop possesses energy due to its mass motion; the energy liberated when it freezes is much greater; and the energy involved in the formation of the drop from oxygen and hydrogen is greater still. May not the energy of atomic synthesis and disintegration be as much greater than that of ordinary chemical change as the latter is greater than the energy of physical change? The view advanced by Elster and Geitel appears to me to give the best explanation that has yet been offered. But this question of the energy of the rays, like many other questions that have been raised by the study of radioactivity, can by no means be looked upon as settled.

Ernest Merritt.

THE TWENTY-FIFTH ANNIVERSARY OF DOCTOR VICTOR C. VAUGHAN'S GRADUATION.

On the 18th of June there was presented to Doctor Victor C. Vaughan, in the presence of alumni, students, colleagues and friends, a volume of contributions to medical research, containing thirty-four papers, dedicated to him by colleagues and former students of the department of medicine and surgery, in honor of the twenty-fifth anniversary of his doctorate.

ADDRESS OF PRESIDENT JAMES B. ANGELL.

Ladies and Gentlemen: My duty is a very simple and a very pleasant one, as the official head of the university, to express the gratification which the authorities of the university, as well as alumni and undergraduates, feel on this interesting occasion. We have come to follow a very agreeable custom, which we may say we are indebted to our German friends for establishing, of recognizing the services of a friend who has been of great use to this institution; and I am very glad that in introducing this pleasant German custom we have here the countenance of our German friend, Dr. Kiefer, who has done so much for this movement. I should prefer that he would have discharged this pleasant duty, but it is proper, perhaps, that I should appear, if only for a moment, in these services.

I am one of the gentlemen here who are old enough to remember when Doctor Vaughan was very young. I can well remember when we had the great pleasure of importing him from the trans-Mississippi region and the pleasure with which we watched his brilliant progress as a student. The medical department of this university has undergone great changes since that time. The courses of instruction were much briefer then, the period allotted to the study of medicine was very much shorter than it is now, and I presume those young gentlemen on the upper seats will believe that it was much less rigorous than it is now. The instruction was very largely given by lectures, and perhaps some of these recent graduates will be surprised to learn that some of the gentlemen in the faculty at that time very strenuously urged that it was far more profitable for the students to hear the lectures the second time than it was to hear them the first time. I used to argue this question out at length with one of the professors, because as a layman it was very difficult for me to understand how hearing the whole course of lectures the second time helped matters, but I was assured that, pedagogically, it was right, that it took the first year to mellow the medical student's mind up to the point where in the second year he could understand what was meant by the lectures. As you look down upon some of these older graduates, who went through that process of training, you must not interpret too literally as correct that view of the case. I presume these gentlemen will deny that that was the pedagogical reason for that course of instruction.

As I have said, the medical work in those days was more largely given by lectures than at present. The laboratory courses have come into use since that time. It is due very largely, I may say, to the dean of the department, though doubtless by the aid of many of his associates, that so great emphasis is now placed upon this new, and more profitable, mode of scientific instruction. Of the important part that he has played during these twenty-five years, I need myself hardly speak in detail; I can assure you, however, that it was with great pleasure that we who had witnessed his career as a student saw him very early fulfilling the promise which he had given as a student, in the brilliant

scientific discoveries which he has made, and which are of great importance in the hygienic history of his time. The promise that he then gave has been more than redeemed up to the present time, so that not only is his name well known and the name of the medical department of the university through him well known in this country, but also in all European countries.

I am sure there is no one here and no one ever connected with the university who does not feel grateful to him for the services he has rendered. Still more are we glad, notwithstanding his twenty-five years of service, to look into his face and see that he is still a young man and doubtless has a long career yet before him, and we shall be very glad to come here—some of you will have a better chance than I—twenty-five years hence to have another and more imposing celebration.

I am sure you all rejoice with us on this occasion, and I shall not detain you from the pleasure of enjoying the services which have been more especially appointed. I have risen merely to speak an official word, and also to have the pleasure of speaking a personal word of congratulation to one whom I delight to count as one of my most cherished friends.

Professor Albert B. Prescott, of the University of Michigan, made the presentation in behalf of the contributors.

ADDRESS OF PROFESSOR ALBERT B. PRESCOTT.

Fellow Alumni and Friends: I am honored surely in being asked to say something in this presentation of a gift to-day. It is a privilege as well as an honor to speak on the part of such men as those who are making this gift, men who are the most cherished and most influential of the medical alumni of this university.

For gifts there are returning times and seasons. For a gift there is now and then a period standing almost alone by itself. Of gifts there are various kinds and various meanings. Whatever a gift may be, it means more than it is. It is a mode of speech, a form of expression, a record of events. In the making of this gift a memorial volume has been wrought out piece by piece in the unwearied toil of strenuous life. For the making of this gift we have a quarter of a century, a period in the lifetime of an alumnus, an era in the history of this university, a memorable period in the advancement of a great scientific profession. The occasion is one that touches all our hearts.

This Festschrift is a symposium of scientific learning, a production of lasting import, an essential record of the advancement of science and of the profession of medicine. It consists of thirty-four separate investigations, each one conceived in faith and wrought in patience, each one the chosen product of its author's personal power. In such a piece of research work as is undertaken in the making of any one of these papers we can but imagine how advances are gained step by step, finding out what is right by proving what is wrong, reaching forward in this direction and then in that, assured that every result of truth adds something, may add much, to the sum of the knowledge and power and good of mankind.

If I were competent to speak of these records of researches in the domain of medical knowledge, I should not have time now even to enumerate them, but I recognize that they are from men who have become authorities in the world, by their several investigations and through their experience in scientific pursuits. As I look over the titles of these papers I see that they form a symposium of research, embracing certain fundamental principles, and presenting a series of discoveries, which unite together naturally

and inevitably to constitute a tribute of honor to the one man unto whom this gift is now being made. The book belongs to him, by virtue of its history and by virtue of its subject matter. We are but rendering what is due, and so this gift is made to you, Doctor Victor C. Vaughan, made to you as an acknowledgment of the services you have rendered to the world of science and this university, to the cause of medical education, to advances in scientific work wherever undertaken.

We have great pleasure in recalling, as President Angell has so feelingly done, the last quarter century of progress in this university. It is in fidelity to the spirit of advancement, and to service of the truth, that this volume is presented. It is in the conviction that scientific labor is at the heart of education and educational means and methods, that this expression is made. It is to you, Victor C. Vaughan, who twenty-five years ago received the degree of doctor of medicine from this university, previously having received two degrees in science, upon examination here; our friend known and honored in the country and in the world, major and surgeon of the United States Volunteers, a trusted counsellor, preeminently a leader in the work in which you are engaged, in the name of the working contributors to this volume, in the name of the alumni of the department of medicine and surgery, in the name of all the alumni of the university, we take great pleasure in placing this volume in your hands.

ADDRESS OF PROFESSOR VICTOR C. VAUGHAN.

On accepting the volume, Professor Vaughan spoke as follows:

Mr. President, Gentlemen of the Board of Regents, Doctor Prescott, Members of my old class, Colleagues and Friends: This I do not deserve. The world has been more than kind to me; my friends have conferred upon me many honors, which might have been more worthily worn by others; but I have never received an honor which I appreciate more highly and in the receiving of which I feel more keenly my unworthiness than in this. The work that I have done for the university and for science is overestimated by those who have been kind enough to speak.

I owe much to the University of Michigan. Thirty years ago when I had secured the best education possible in my native state, and when I was looking about for an opportunity to pursue my studies farther, the state of Michigan offered me what I desired and at a cost within the limits of my scanty purse. Whatever I have done, and whatever I may do in the future, will hardly repay the University of Michigan for what it has done for me. This is my feeling towards the university. To those who make up the university, I owe much. To our worthy president, to whom I have always gone in times of discouragement for words of cheer, to whom I have always gone in times of indecision or doubt for wise and able counsel, I owe much. To the honorable members of the board of regents I owe much. A few years ago, when it became necessary, on account of death and resignation, to reorganize the medical department, the members of the board of regents enabled me to select the present most excellent medical faculty. To my colleagues in the university as a whole I owe much. It has been a pleasure to live among them; it has been an inspiration to work and be associated with them; and, so far as my immediate colleagues on the medical faculty are concerned, I am in the habit of saying, and with great truth, that of all of the research work that I have ever done, the grandest and best piece is that, by the authority of the board of regents, I have been able to

collect together a medical faculty every member of which is a master in his specialty.

It is easy enough to have a good medical school, and it is easy enough to be dean of such a school, if you have a good faculty and good students, and I owe much to the students in this department. I want to say that the spirit for good, honest work and the inclination to be gentlemanly and honorable in everything have always prevailed among the student body in this university. It is an honor to me that I have been associated as teacher with some of the greatest scientific men in this country; however, these men do not owe their attainments to any instruction that they have received from me. They would have been great and probably greater still had their instruction been received from others.

I want especially to express my personal gratitude to him from whose hands I have received this volume. When I came a student to the University of Michigan, Doctor Prescott was then, and he still is, the Nestor of scientific research in this university. From him more than from any other man have I received the inspiration for scientific work which has led me to accomplish whatever I have done. I well remember one of the first problems at which he placed me. It was a new test or a newly reported test for arsenic, reported by one of the most distinguished of chemists, and the doctor asked me to determine its delicacy. I reported from day to day and week to week as to the delicacy of the test, until I was getting it down to high dilutions. One day when I made such a report the good doctor raised his eyebrows and said that possibly I might make that test without any arsenic present, and I made it and found the result equally positive.

President Angell has explained how it is that my classmates who occupy the second and third rows of seats before me, the class of 1878, got through the university. It was necessary, in order to get us through, that the lectures be repeated to us for two successive years and in this way we were finally nourished sufficiently to become doctors and be turned out on the world.

Now, my friends, in accepting this volume I shall not regard it as a trophy of any achievement. I shall regard it as a tribute of love and respect, which I shall prize more highly than anything else, from my colleagues, my students and my friends. In its pages I expect to find inspiration for farther work; in its pages I expect to find comfort in my hours of rest and when I am through with it I shall bequeath it to my children as my most valuable earthly possession. I take it, that this volume is presented to me as a result of the spirit of scientific research of those who have made these contributions, and I wish to say to the honorable board of regents that I hope that you will grant me the privilege never denied an old servant, to offer one word of advice and to say that if you wish to maintain the glory, honor and reputation of this university, you will encourage the young man who is able to do research work. It was not until scientific research came with experimental investigation, that the world began to grow and develop until within the last century its progress has been greater than in all the preceding centuries. It is scientific research that has made the German universities the very center not only of science, but of letters as well. I read only a few days ago a very interesting book by a graduate of Oxford, entitled 'Oxford at the Cross-Road,' and this man inquires whether Oxford and Cambridge are to continue as literary boarding houses, or whether they are to join the great universities of other

lands in working out the problems of the twentieth century. Scientific research has not always found the most congenial atmosphere in American universities. It has not been as thoroughly appreciated as it might be and as it should be, and the American university of to-day, like Oxford and Cambridge, stands at the cross-roads. Shall it be an enlarged and amplified high school, or shall it become a center for the evolution of knowledge and discovery. Has not the state the right to ask of its university the very best knowledge possible upon every subject in which the welfare of the people may be involved?

My friends, my heart, always larger than my head, overflows with the emotions which my poor tongue can not adequately express. I desire to thank all of you for this highly appreciated, but, I fear, poorly deserved, tribute.

SCIENTIFIC BOOKS.

A Text Book of Plant Physiology. By GEORGE JAMES PEIRCE, Ph.D., Associate Professor of Plant Physiology, Leland Stanford Junior University. New York, Henry Holt and Company. 1903. 8vo. Pp. vi + 292.

The author of this work in his preface, which bears date of December, 1902, says that the book is the outcome of his own work in Stanford University, and that after the material had been worked over for some time in lectures it finally took form in the present volume. His intention is 'to present the main facts of plant physiology and the saner hypotheses regarding them, striving to express safe views rather than to echo the most recent, attempting here and there to suggest definite problems for investigation and everywhere trying to avoid giving the impression that the science or any part of it has reached ultimate knowledge and final conclusions.' This intent on the part of the author has been well carried out, and we may congratulate him upon the book which he has added to American botanical literature. He has made no attempt at giving directions for experiments, 'believing that a laboratory manual and a text-book must meet such different needs that the style of the one is impossible for the other.' However, the author insists that actual laboratory work must be carried on under the guidance of a teacher in the study of the subject.

Dr. Peirce gives his ideas as to the aim of physiology in the following words, which we may well quote:

"According to Pfeffer, 'the aim of physiology is to study the nature of all vital phenomena in such a manner that, by referring them to their immediate causes, and subsequently tracing them to their ultimate origin, we may arrive at a complete knowledge of their importance in the life of the organism.' Physiology is a study not merely of structure, though to its successful pursuit a knowledge of structure is indispensable; nor of organized bodies, though a knowledge of the laws which govern their organization (structure and form) is important. It is the study of the living organism."

On a later page he says: 'The physiologist is now striving not only to know the functions which are the manifestations of the life possessed by complicated living structures or organisms, but also to determine the causes, both of structure and of functions.'

These quotations will sufficiently indicate the spirit in which the book is written.

In the introductory chapter there is an instructive summary under the heading 'The Conditions Essential to Life' as follows:

"1. Proper Food—(*a*) the source of the materials of which the body is built, and (*b*) of the energy by which the body is built and operated.

"2. Water—(*a*) the vehicle of the food-materials and of the foods absorbed into the body and transferred from part to part, and also (*b*) an indispensable component of actively living protoplasm.

"3. Proper Temperature—which makes possible the vital, *i. e.*, the chemical and physical, changes which must go on within the body, and in all of its parts, lest inaction and death ensue.

"4. Proper Illumination—which furnishes the organism with the forms of energy—physical and chemical—thermal, luminous and actinic—of which it is directly or indirectly in need.

"5. Proper Freedom—freedom from mechanical and other disturbances which would interfere with its supply of food, water, warmth and light, and prevent it from carrying on its natural functions."

And again, under the heading 'The Living Matter and the Actively Living Structure,' the author says:

"As Hertwig has so strongly emphasized, the living and active protoplasm is to be regarded not as a chemical compound or an association of chemical compounds, but rather as an orderly arrangement of these into a definite structure, of which water is an indispensable constituent. Some of the water contained within the cell should be considered to be as much a constructive constituent of the living protoplast as the water is of the crystal of copper sulphate. As, without a certain amount of water, one can never have crystals, no matter how much copper sulphate may be present, so also, without the necessary amount of water we can never have active protoplasm. When the water of constitution is withdrawn, all the activities of the cell cease with the demolition of its structure."

In the carrying out of the author's plan he devotes one chapter to nutrition, another to absorption and movement of water, still another to growth, one to irritability and one to reproduction. In the chapter on the absorption and movement of water the author's treatment of transpiration is interesting. Thus, on page 136, we find the following:

"From all their surfaces exposed to the air, plants give off water-vapor. This is a physical necessity, for water-vapor will be given off from any mass, lifeless or living, which contains water, whenever the surrounding air is not saturated with moisture, or when the mass has a temperature higher than that of the air, or when the mass, in relatively dry air, is not enclosed in a waterproof covering. Other things being equal, the amount of water-vapor given off will be greater the greater the exposed surface in proportion to the mass. With like conditions of humidity, temperature, surface-composition and surface-area, equal masses of different composition, will dry, *i. e.*, lose water by evaporation, at different rates, a gelatinous or slimy mass more slowly than a woody one, for example. The living plant differs from a dead one of exactly the same dimensions in being able to control four of these five factors, and to that degree it is able to control the rate and the amount of evaporation. Because evaporation from the body of the living plant is controllable within certain limits by the plant itself, and to this extent is a physiological process, it has been given the separate name of transpiration."

After a little further discussion he says: 'Transpiration is, therefore, a physical process controlled but not carried on by the living plant. According to circumstances it may be more or less rapid than simple evaporation.' This view of the nature of transpiration is one which the present reviewer has held for many years, contrary to the views of many of the older physiologists, and it is gratifying to find that Dr. Peirce holds this physical view of the transpiration process.

In passing we notice with interest what the author has to say with reference to ecology, to which he refers very briefly on pages 252–253. Of it he says: 'Meantime it is more or less the fashion under the name of ecology to view things in the large way, and by feeling rather than by the application of exact physiological methods, to reach conclusions regarding the effects of environment and of association.' We gather from this that the author has little use for the looser ecological methods, and in this again the present reviewer must heartily agree with him.

The volume is full of original suggestions, and differs quite markedly from the old-time works devoted to plant physiology. We congratulate the author upon the success which we are sure must attend the publication of this book. CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

Caterpillars and their Moths. By IDA MITCHELL ELIOT and CAROLINE GRAY SOULE. New York, The Century Company.

In this handsome book of more than three hundred pages we have a very valuable contribution to the literature of popular entomology. The authors have mapped out for themselves a special field and have occupied it to excellent advantage. The caterpillars chosen for treatment are those of the larger moths, especially the more common ones, no

attempt being made to discuss the vast array of species in the Micro-lepidoptera.

The book is divided into two parts, the first fifty-six pages being devoted to the six chapters of Part I. In these chapters general directions for collecting, studying and rearing caterpillars are given—directions of great value to the beginner and of decided suggestiveness to the experienced entomologist. The remaining eleven chapters are devoted to the biographies of many species of Sphingidæ, Arctiidæ, Saturniidæ, Ceratocampidæ, Limacodidæ, Notodontidæ and Noctuidæ. These life histories are written in simple, lucid English, each insect being described in its progress from the egg to the adult in a way that any one can understand. The usefulness of the book is greatly increased by the admirable illustrations from photographs of living caterpillars and spread moths by Miss Edith Eliot. These are certainly among the best photographs of living insects that have been published.

The authors and the illustrator are to be congratulated on having prepared a book which will be of use not only to entomologists, but also to great numbers of teachers and pupils interested in nature study in the schools.

Clarence M. Weed.

SCIENTIFIC JOURNALS AND ARTICLES.

The June number (volume 9, number 9) of the *Bulletin of the American Mathematical Society* contains the following articles: 'Singular Points of Functions which Satisfy Partial Differential Equations of the Elliptic Type,' by M. Bôcher; 'Errata in Gauss's Tafel der Anzahl der Classen binärer quadratischer Formen,' by A. M. Nash (communicated by E. B. Elliott); 'The Logarithm as a Direct Function,' by E. McClintock; review of Klein-Fricke's 'Automorphic Functions,' by J. I. Hutchinson; review of Loria's 'Special Plane Curves,' by E. B. Wilson; 'Shorter Notices'; 'Notes'; 'New Publications.' The July number of the *Bulletin* contains: Reports of the April meeting and sectional meetings of the society; 'A Fundamental Theorem with Respect to Transitive Substitution Groups,' by G. A. Miller; 'The Characterization of Collineations,' by E. Kasner; review of Goursat's 'Cour d'Analyse,' by W. F. Osgood; 'Shorter Notices'; 'Notes,' and 'New Publications'; 'Twelfth Annual List of Published Papers' and index of volume 9.

The July number (volume 4, number 3) of the *Transactions of the American Mathematical Society* contains: 'On the Point-Line as Element of Space: A Study of the Corresponding Bilinear Connex,' by E. Kasner; 'On the Formation of the Derivatives of the Lunar Coordinates with Respect to the Elements,' by E. W. Brown; 'On Reducible Groups,' by S. Epsteen; 'Theory of Linear Associative Algebra,' by J. B. Shaw; 'Projective Coordinates,' by F. Morley; 'On an Extension of the 1894 Memoir of Stieltjes,' by E. B. Van Vleck; 'On the Variation of the Arbitrary and Given Constants in Dynamical Equations,' by E. W. Brown; 'The Primitive Groups of Class $2p$ which Contain a Substitution of Order p and degree $2p$,' by W. A. Manning; 'Complete Sets of Postulates for the Theory of Real Quantities,' by E. V. Huntington.

The University of Chicago will begin the publication on January 1 of a journal of infectious diseases, edited by Professors Ludwig Hektoen and E. O. Jordan. It is said that the journal will be endowed with $125,000 by Mr. and Mrs. Arnold F. McCormick.

SOCIETIES AND ACADEMIES.

THE UNIVERSITY OF CHICAGO MEDICAL CLUB.

The University of Chicago Medical Club, organized October, 1901, began its second season with a special meeting on December 1, 1902, at which Professor G. N. Stewart, who has succeeded Professor Loeb in the chair of physiology at the university, presented an interesting paper on 'Problems and Methods of Modern Physiology.'

On January 19, 1903, the club held its first regular meeting for the season, electing as officers for the year, Lewellys F. Barker, president, and Frank R. Lillie, secretary.

Meetings of the club were held through the winter and spring, as usual, once a fortnight,

and the following papers were presented in the order given:

DR. WILLISTON: 'The Fossil Man of Lansing, Kansas.'

DR. LUDWIG HEKTOEN: 'The Memorial Institute for Infectious Diseases: Its Purposes and Plans.'

DR. SHINKISHI HATAI: 'The Development of the Ventral Nerve Roots in the White Rat.'

DR. C. B. DAVENPORT: 'Recent European Work on Experimental Evolution.'

DR. P. BASSOE: 'A Case of Gigantism and *Leontiasis Ossea*' (illustrated).

DR. L. HEKTOEN: 'A Case of So-called Congenital Rickets' with lantern slides.

DR. E. O. JORDAN: 'The Recent Epidemic of Typhoid Fever in Ithaca, N. Y.'

DR. L. F. BARKER: 'The Morbid Anatomy of Two Cases of Hereditary Ataxia' (family described by Dr. Sanger Brown).

DR. H. G. WELLS: 'Fat Necrosis from the Standpoint of Reversible Enzyme Action.'

DR. A. P. MATHEWS: 'On the Nature of the Action of Salts on Protoplasm.'

DR. E. P. LYON: 'Experiments in Artificial Parthenogenesis.'

DR. CHAS. INGBERT: 'An Enumeration of the Medullated Nerve Fibers in the Dorsal Roots of Spinal Nerves of Man.'

DR. S. A. MATHEWS: 'The Diuretic Effect of Combined Salt Solutions.'

THE June number of the *Biological Bulletin* contains the following articles:

AXEL LEONARD MELANDER and CHARLES THOMAS BRUES: 'Guests and Parasites of the Burrowing Bee *Halictus*.'

J. B. JOHNSTON: 'The Origin of the Heart Endothelium in Amphibia.'

J. W. SCOTT: 'Periods of Susceptibility in the Differentiation of Unfertilized Eggs of Amphitrite.'

ARTHUR W. GREELEY: 'Further Studies on the Effect of Variations in the Temperature on Animal Tissues.'

BENNETT M. ALLEN: 'The Embryonic Development of the Ovary and Testis of the Mammalia' (preliminary account).

DISCUSSION AND CORRESPONDENCE.

ANTARCTICA.

TO THE EDITOR OF SCIENCE: In the *Geographical Journal of London* for May, 1903, there is a four-and-a-half-page review by Dr. Mill of my monograph 'Antarctica.' May I crave space in SCIENCE to bring before American scientists some of the points touched on?

Dr. Mill says: 'Mr. Balch surely does not need to be assured that no British geographer would dream of withholding credit from any explorer on the ground of his nationality, least of all if that nationality were American.' Let me answer this by some instances.

During the last six decades certain European geographers have made repeated attempts to decry Wilkes and his officers. As late as 1901, Lieutenant Colbeck, of the Royal Navy, now commanding the *Morning*, published in Mr. Borchgrevink's book, 'First on the Antarctic Continent,' a chart on which the southward track of the *Southern Cross* is marked as between 161° and 162° east longitude down to 66° south latitude, a spot at least three degrees distant from the most easterly point of Wilkes Land. The *Southern Cross* then sailed eastward and never approached Wilkes Land proper at all. Nevertheless Lieutenant Colbeck called his chart "Track of Sy. 'Southern Cross' over Wilkes Land."

Sir Clements R. Markham has made, during the last twenty years, many a disparaging statement about Wilkes and his men. Finally, in his article in the *Geographical Journal* for November, 1899, he says: 'The Victoria Quadrant first presents, for examination, the lands sighted by Balleny and Dumont d'Urville from 118° E. to the Balleny Islands in 162° E., namely, Adelie and Sabrina lands.' *Wilkes is not mentioned.* In other words, in this case the president of the Royal Geographical Society ignores absolutely American discoveries and American explorers.

Dr. Mill himself, it seems to me, is not quite fair to Fanning, upon whose veracity he casts reflections, not only in his present review, but also in the February number of the *Geographical Journal*. There is no reason whatever to impugn the veracity of Fanning, who was an American, as was Morrell, whom Dr. Mill also attacks, and it is worth while calling attention to the fact that Dr. Mill does not attack a single English explorer.

Dr. Mill finds fault with me because I

think Cook's voyage of less importance in antarctic geography than Wilkes' voyage. He says: "If such extraordinary reasoning were to be allowed, one might say far more justly of the first transatlantic voyage: 'North America was not discovered, a fact which would seem to rank the voyage of Columbus as of much less importance than the voyage of Cabot.'" But if Dr. Mill had compared the voyage of Columbus with the voyages of Columbus' predecessors, his simile would have been exact. A number of men sailed westward before Columbus, but their efforts produced no tangible result beyond showing that the ocean was a big space of water. But Columbus brought out the fact that there were great lands in the west, and for this he justly gets deserved credit. In the same way Cook only found ocean and ice round the South Pole, while Wilkes first discovered the existence of an Antarctic continent, and he, therefore, like Columbus, is entitled to the credit of the discovery.

Dr. Mill states that I have 'done a patriotic service, and also a service to science, in setting out the real achievements of Charles Wilkes,' and for this I beg to thank him. But he says I claim for Wilkes 'first discovery.' I have never claimed that Wilkes was the first to sight land in the Antarctic. On the contrary, I think it may have been Don Gabriel de Castiglio in 1603, or perhaps some entirely forgotten mariner whose possible discovery of West Antarctica before 1569 may have been the origin of the 'Golfo de S. Sebastiano' on the charts of Mercator and Ortelius. What I claim for Wilkes is that he was the first to discover land masses which were probably continental in their dimensions, and the first to announce to the world the existence of the probable South Polar continent. And every Antarctic discovery since the time of the American Exploring Expedition goes to show that Wilkes was correct.

Dr. Mill says that I am 'unjust to the memory of Sir James Clark Ross.' He does not specify how, but he apologizes for Ross as follows: 'We feel sure that Ross was not aware of Wilkes' orders dated 1838 at the time he wrote of the American and French expeditions.' Yet Ross had read Wilkes' 'Narrative,' for he quotes it repeatedly. Of the long and serious investigation I made of Sir J. C. Ross' charges against Wilkes—in which I stated that Ross paid no attention to the statements nor to the charts published by Wilkes, but quietly started a grievous error, and also that none of Wilkes' discoveries were disproved by Ross for the simple reason that Ross never was within sighting distance of any part of Wilkes Land—Dr. Mill does not say a word, and by his silence, therefore, he assents to my conclusions.

EDWIN SWIFT BALCH.

THE SPECIFIC HEAT OF MERCURY.

TO THE EDITOR OF SCIENCE: May I direct attention to a corollary to the recently published work of Messrs. Barnes and Cook on the specific heat of mercury?* In these experiments a slender thread of mercury was heated by passing a current through it, and the results agree fairly well with other results obtained by previous experimenters who heated mercury in the ordinary way. The agreement might be still closer if the other results were as accurate as those of Messrs. Barnes and Cook. Petterson and Hedelius (quoted in the article referred to) failed to work accurately enough to detect the decrease of the specific heat with rise of temperature, and Regnault even thought the change to be in the opposite direction. As it is, the results agree well enough to show that, to about one part in 300, *the specific heat is not altered by the passage of a current.*

This fact, I think, can hardly be self-evident, and is worth an experimental proof. Specific heat is known to vary with temperature, *i. e.*, rapidity of agitation of the molecules, and experiments along this line may give us a clue to the nature of conduction, whether this takes place entirely through the intermeshed ether, or partly by a motion (twisting or otherwise) of the particles.

That the same is true for water as for mercury has been shown by the experiments

* *Physical Review*, February, 1903.

of Callendar with the same apparatus, described in the British Association 'Report' of the Toronto meeting, 1897. I have thought it worth while to test the same for solids. Carbon was the substance chosen, as being a conductor and as having the greatest known variability of specific heat with temperature and, therefore (presumably), with other disturbing factors. The method employed was to heat a fine carbon rod by a heavy current, and watch its expansion by means of an optical lever.

If a vessel containing a given quantity of water have its capacity suddenly altered by a bulging or a constriction of its sides, the result will be a change of level of the water. And if the specific heat of the carbon rod be suddenly altered when the current is started or stopped there should be observed a change of temperature which I hoped to detect by an abrupt alteration in the length of the rod. The results were entirely negative. The rod used was of French make, a Carré electric light carbon, 51 cm. long and 0.15 cm. diameter, wrapped in tissue paper and enclosed in a glass tube. Its resistance (cold), according to the nature of the contact made, was from about eleven ohms upwards. The rod was mounted vertically, its lower end resting in a mercury cup, and its upper end tilting a small lever on a knife-edge bearing. On this lever was mounted a galvanometer mirror. The current was taken from the upper end of the rod by a wire wrapped tightly around it. The tilting of the mirror was read by means of a telescope and a vertical scale placed two and one half meters away. The current used was three amperes. When the current was started or stopped a perfectly steady motion of the scale was observed. A jolt of 0.05 cm. in the field of the telescope could have been detected.

As about 6 cm. of the scale passed the cross wires before the still damp mucilage holding the tissue paper around the carbon began to steam, it will be seen that a jolt of 0.05 cm. would have meant a change in temperature of about two thirds of a degree, taking the initial temperature of the carbon as 20°, or 293° absolute. And a difference of level of two thirds of a degree in 293° would have meant an alteration in the heat capacity of about one part in 450. PAUL R. HEYL.

THE RANDAL MORGAN PHYSICAL LABORATORY,
UNIVERSITY OF PENNSYLVANIA.

THE PROPOSED BIOLOGICAL LABORATORY AT THE TORTUGAS.

TO THE EDITOR OF SCIENCE: In SCIENCE, June 12, 1903, is a letter by Professor C. B. Davenport upon the proposed biological station at the Tortugas. There are two sentences in it which I feel it necessary to comment upon. The first is: 'On the Pacific coast we have the Hopkins laboratory and that of the University of California.' The second is: 'While we are planning a chain of marine stations certainly * * * Puget Sound should be considered.' No doubt Dr. Davenport, who is quite familiar with the fact that the Minnesota Seaside Station at Port Renfrew, British Columbia, is just entering upon the third year of not altogether unsuccessful effort, means by 'we' the biologists of the United States. Under this construction it is altogether proper for him to omit the Minnesota Seaside Station from his calculations. In view of the fact, however, that this station, although upon Canadian soil, from which a number of memoirs and one volume of the yearbook, *Postelsia,* have already been published, is managed in connection with one of the American universities and has drawn its clientele principally from the western United States, it seems proper that it should be included as one of the Pacific coast stations of America. Its position on the Straits of Fuca was selected with great care so that it might be accessible as a center for the study of the fauna and flora not only of the sound but also of the open sea.

The Minnesota Seaside Station has not passed through the stage of an extended discussion in the columns of SCIENCE, nor has it intimated its pressing wants to Mr. Carnegie or any other millionaire. It has risen quite peacefully and modestly upon a cooperative basis which is none the less favorable for respectable work. Every year has seen considerable improvement both in its buildings and

equipment. It may or may not have the qualities of permanence. In any event, while it is upon its present basis, it is freely open to such students and investigators as might wish to work in its vicinity.

Conway MacMillan.

To the Editor of Science: I have been asked by Dr. A. G. Meyer to express an opinion regarding the establishment of a marine biological laboratory in the tropical Atlantic. As I have never been south of Bermuda, in these waters, I do not know that my ideas on the subject will be of much value. I see by the letters already published that the Tortugas are very generally favored. While for a botanist who is a student of marine algæ only, such a location might be an excellent one, it would hardly be suitable for one who wanted to study any other aspect of botany, for if I am not mistaken the land flora there is exceedingly scanty. A laboratory to be much sought after by botanists must also afford opportunities for the study of land plants, and where tropical vegetation is desired one must go further south than the Tortugas, and in a region where there is more moisture, to find much that is worth while.

Herbert M. Richards.

Barnard College, New York,
June 16, 1903.

THE MEDICAL RESEARCH LABORATORY OF COLORADO COLLEGE.

To the Editor of Science: It is proposed on the part of Colorado College to establish a pathological and research laboratory. For this purpose a room 23 by 14 feet has been set aside in the new Science Hall, now under erection. This room is to be equipped with chemical hood, water, gas and storage battery facilities. There are two windows in the room having a south exposure. In this laboratory it is planned that the following lines of work be undertaken: (1) Blood examinations, (2) sputum examinations, (3) urine examinations, (4) drinking-water examinations, (5) milk examinations, (6) pathological examinations, (7) stomach contents, (8) feces, (9) X-ray work as an aid to diagnosis, (10) papers and fabrics for mineral poisons.

In addition to these lines of general work special cases, requiring expert knowledge and care, will be undertaken. It is also planned that the director of the laboratory pursue lines of original research such as may be suggested by himself or by members of the committee under which the laboratory is to be conducted. It is hoped that this will grow to be the most important feature of the whole undertaking. Finally the laboratory will offer a limited amount of instruction in the pre-medical course of Colorado College. The amount and character of this instruction will be determined by consultation with the president of the college.

The salary of the director will be $1,500 for the first year. It is hoped that thereafter the income of the laboratory will prove sufficient to warrant an increase. It is the desire of the committee to receive applications for the position of director of the laboratory, the appointment being made for one year. The applicant should be a man of scientific spirit and one who is desirous of making his reputation along lines of medical research. It is not essential that he be a graduate of a medical college, but rather that he have had training and experience in some of the best laboratories of this country or Europe. He should not be a person expecting later to enter the practice of medicine.

Applications with full information and testimonials may be sent to

W. F. Slocum.

Colorado College,
Colorado Springs, Colo.

ABBREVIATIONS OF NEW MEXICO.

May I suggest that the name New Mexico should always be abbreviated (if at all) to New Mex. or N. M., never to N. Mex. or N. Mexico? The latter abbreviations have been used a great deal by naturalists, with the result of producing much confusion between New Mexico and North Mexico. Foreigners, especially, are almost sure to take N. Mexico for North Mexico; and I am afraid a good many people, not all foreigners, do not know that there is any difference! (I received the other day a letter from an important scientific

establishment in New York, with five cents in stamps on the envelope!) I am aware that in several of my own published papers the objectionable abbreviations occur, but these (and many other queer things) are due to editorial interference.

T. D. A. Cockerell.

'TABLETTES ZOOLOGIQUES.'

To the Editor of Science: Will you kindly give me space to inquire if any reader of Science knows of the existence in the United States of a copy of the 'Tablettes Zoologiques'? This journal was published at Poitier, France, by Aimé Schneider. The first volume appeared in 1885, and the third, which I think was the last, in 1892. I have as yet been unable to locate a copy in America, and any information will be very gratefully received.

Howard Crawley.

Wyncote, Pa.,
June 12, 1903.

SHORTER ARTICLES.

UNUSUAL ABUNDANCE OF A MYRIAPOD, PARAJULUS PENNSYLVANICUS (BRANDT).*

During the latter part of August and the first of September, 1902, the walks and drives along the university campus were overrun with a myriapod which proved to be *Parajulus pennsylvanicus* (Brandt). Bright, sunny days, which were likewise cool, were observed to bring a greater number of the species into evidence. Complaints were made by residents along the adjacent avenues of the numbers of these 'worms,' as they were called, which covered the sidewalks and terraces and even entered the residences. Often in passing along the paths running in the campus it was found to be difficult, if not impossible, to avoid crushing numbers at every step. They exhibited no general direction to their movements, and hence a migration from one portion of this locality to another definite locality seems not to be the case. Rather it seems that they were trying to find higher or perhaps dryer ground. When one was taken up in the fingers and then allowed to move in a direction opposite to its original direction, it showed no sign of any attempt at orientation.

A case similar to this one is found every year on Cedar Point, Sandusky, O., where *Fontaria indiani* Bollman, immediately prior to and during ovipositing, is found in great numbers along the lowlands on the Bay side. But in the case of the one mentioned above as occurring on the campus, of all the females examined, none contained eggs. Hence this is not a true parallelism.

Several cases of extensive migrations of myriapods are on record. In the *Zoologischer Anzeiger* for 1900, Verhoeff records a migration of such extent that railroad trains were stopped, owing to the numbers that were crushed under the wheels and thus caused them to slip. The species in this case was *Julus terrestris*. Verhoeff also calls attention to a description of an extensive migration of a species of *Brachyjulus*, given in the same journal by an Austrian named Paslavisky, who states that in 1879, in Austria, this species was excessively numerous in a certain district. Verhoeff regards the cause of such movements as due to over-population, and hence an attempt to obviate the results of the law of Malthus. That this is not the cause in all cases is attested by that of the species of *Fontaria* that I mentioned as occurring on Cedar Point, which is undoubtedly a purely sexual matter. A third record of such movements is given in Bollman's 'Myriapoda of North America,' in which, on page 75, he mentions the occurrence of *Fontaria virginiensis* (Drury) in Donaldson, Arkansas, in such numbers as to attract general attention. The adults were found to bear a ratio to the number of young that were observed with them of about one to three hundred. Apparently, this movement is due to a third reason—the migration of the adults with the young. Miss Mauck (*American Naturalist*, XXXV., 447) gives an account of a migration of *Fontaria virginiensis* (Drury) but no cause is assigned to the movement.

To conclude, every one of the cases of extensive migrations in myriapoda that have

* Read at Columbus meeting, Ohio Academy of Science, November, 1902.

been recorded seems to have a cause peculiar to itself. This may be either connected with mating or it may have nothing to do with it, as seems to be the case with the form described as occurring about the university campus. As a possible explanation of the movement in the present case, it may be offered that it is a preparation for winter. The adults live over the winter under logs, leaves, etc. Their eggs are laid in low, damp areas. Such localities are unfit for hibernation, and hence the migration to more dry and protected localities.

Max Morse.

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Ohio State University.

RECENT ZOOPALEONTOLOGY.

STEGOCERAS AND STEREOCEPHALUS.

This review of the above-named genera of dinosaurs, by the able paleontologist Franz Baron Nopcsa (Centralblatt für Mineralogie, etc., 1903, No. 8), is a highly important one and is, at the same time, suggestive of our limited knowledge of the Dinosauria generally and of the great results to be looked for from the study of this group of reptiles in the future. These animals were recently described by the writer from the Belly River formation of the Red Deer River region. One has a solid horn in the front part of the skull, the other a solidly plated head.

Nopcsa's interpretation of the *Stegoceras* skull elements is noteworthy and accentuates the necessity of having more material for study before definite or final determinations can be made. He comes to the conclusion that the *Stegoceras* specimens that were supposed to be from 'the median line of the head in advance of the nasals'* are to be interpreted rather as representing the frontal and nasal elements of the skull.

In support of this decision attention is called to the frontal of *Camptosaurus prestwichi,* as figured by Hulke in the *Quarterly Journal of the Geological Society* for 1880. In this figure the strong, general structural resemblance to the *Stegoceras* specimens, particularly noticeable on the under surface, is pointed out with emphasis. Reference is also made to a similarly shaped, but as yet undescribed, frontal of *Mochlodon.*

* Geological Survey of Canada. Contributions to Canadian Palæontology, Vol. III. (quarto), pt. II., p. 69, pl. xxi, figs. 1–5.

According to the above interpretation, *Stegoceras* brings to our notice an entirely new type—a unicorn dinosaur, of especial interest in that heretofore a form having an unpaired horn springing from the frontonasal region was unknown.

It is still considered problematical whether *Stegoceras* should be assigned to the Ceratopsidæ or to the Stegosauridæ.

Stereocephalus, the second genus, is referred by Nopcsa to the Acanthopholididæ, and is regarded as a new and important type capable of throwing additional light on the modification of the skull of the Ceratopsidæ.

It is hoped that further contributions to our knowledge of the Cretaceous dinosaurs may be forthcoming from the pen of this sympathetic writer and gifted observer.

Ottawa, Lawrence M. Lambe.
May 26, 1903.

SCIENTIFIC NOTES AND NEWS.

The remaining separata of the late Professor Edward D. Cope have been arranged in sets and are ready for free distribution to students and institutions willing to pay express charges on them. Application should be made to Mrs. E. D. Cope, Haverford, Pa.

Wesleyan University has conferred its LL.D. on William D. Brewer, professor emeritus in the Sheffield Scientific School of Yale University.

The ex-resident physicians and associate physicians of Johns Hopkins Hospital gave a dinner on May 15, at the Maryland Club, Baltimore, in honor of Dr. William Osler, at which he was presented with a copy of the 'Dictionary of National Biography.'

The Zoological Society of London has confirmed the action of the council in granting a pension of £700 to Dr. P. L. Sclater, F.R.S., in consideration of his services to the society for forty-three years.

President W. G. Tight, of the University of New Mexico, is with the Annie S. Peck

expedition in South America to climb Mt. Sorata and to make geological observations.

DR. DOUGLAS H. CAMPBELL, professor of botany in Stanford University, is on a vacation trip to New Zealand and Australia.

MR. ALBERT P. MORSE, curator of the Zoological Museum of Wellesley College, is spending the summer studying the geographical distribution of locusts in the south.

DR. CLEVELAND ABBE, JR., has recently returned to Washington, after spending two years with Professors Julius Hann and Albert Penck in the study of the climatology and glacial phenomena of Europe. He has accepted temporarily a short engagement in the U. S. Weather Bureau, working on the climatology of Guam, for publication in a forthcoming report by Mr. A. E. Safford.

Nature, quoting from the *Victoria Naturalist,* reports the retirement of Sir James Hector, K.C.M.G., from the directorship of the Geological Survey of New Zealand and of the Colonial Observatory.

COMMANDER DON JULIAN IRIZAR, Naval Attaché to the Argentine Legation in London, has been appointed to command the vessel *Uruguay,* which will be sent by the Argentine Government in October to the Antarctic regions in search of Dr. Otto Nordenskjöld's South Polar expedition, which was joined at Buenos Ayres in 1901 by an officer of the Argentine Navy.

Nature states that Professor Steinmann, of Freiburg, and two of his fellow geologists of the same university, have arranged an expedition to the Central Andes of Bolivia. The party will start in August for Buenos Ayres, whence the route to be taken is *via* Jujuy, Tarija, Sucre, to Cochabamba. After a prolonged stay in the mountains the explorers will probably work their way to Antofagasta *via* La Paz.

DR. IRA REMSEN, president of the Johns Hopkins University, gave the commencement address at the Armour Institute of Technology.

WE learn from the *British Medical Journal* that at the meeting of the Zoological Society of London on June 16 Mr. F. E. Beddard, F.R.S., exhibited on behalf of the memorial committee a bust of the late president of the society, Sir William Henry Flower, K.C.B., who before he became director of the Natural History Museum was curator of the museum of the Royal College of Surgeons. The bust has been executed by Mr. Thomas Brock, R.A., and will be placed in the Natural History Museum.

A MEETING was held at London on June 29 to consider the erection of a memorial to Sir Henry Bessemer, to which we have already called attention. It is said that the king is interested in the plan and that Mr. Andrew Carnegie will make a substantial subscription. One of the addresses was made by Professor H. M. Howe, of Columbia University.

MR. GEORGE SHATTUCK MORRISON, one of the most eminent of civil engineers, died in New York on July 1, at the age of sixty years. He was born at New Bedford, Mass., and graduated from Harvard in 1863. Mr. Morrison was especially known for the large number of bridges he constructed, including some fifteen across the Mississippi and Missouri Rivers. He was a member of the Isthmian Canal Commission.

MISS LILLIE SULLIVAN, chief illustrator in entomology in the department of agriculture, died on June 26.

THE deaths are also announced of Carl Gussenbauer, professor of pathology and rector of the University of Vienna; of Dr. Josef de Smeth, formerly professor of psychiatry in the University of Brussels, at the age of seventy-seven years, and of Professor Luigi Cremona, director of the Engineering School of the University of Rome.

THE park commissioners of Chicago have approved the transfer of the Field Columbian Museum from Jackson Park to Grant Park, which is on the lake front in the center of the city. It is understood that Mr. Marshall Field has agreed to give $5,000,000 for the construction and endowment of the museum.

THERE will be a civil service examination on August 1, for the position of consulting

engineer in the U. S. Geological Survey at a salary of $300 a month. The results will depend on experience and previous work, it not being necessary for applicants to appear at any place for examination. There were no applications for this position when the examination was announced on July 1.

The Department of Commerce and Labor was formally organized on July 1. In addition to the Bureaus of Corporations and Manufactures created by the new law, it embraces the Census Bureau, formerly under control of the Interior Department; the Lighthouse Establishment, Steamboat Inspection Service, Bureau of Navigation, United States Shipping Commissioners, National Bureau of Standards, Coast and Geodetic Survey, Bureau of Immigration and Bureau of Statistics from the Treasury Department, the Bureau of Labor, Fish Commission, and the Bureau of Foreign Commerce, the last being transferred from the State Department.

Efforts are being made towards the organization of a society for horticultural science, which would meet in connection with some kindred society, such as the American Association for the Advancement of Science or the American Pomological Society. If there is sufficient interest in the plan the first meeting will be held in conjunction with that of the American Pomological Society at Boston on September 10 to 12. Further information may be obtained from Mr. S. A. Beach, New York Agricultural Experimental Station, Station, Geneva, N. Y.

The American Forestry Association will hold its summer meeting at Minneapolis on August 25 and 26.

The Royal Institute of Public Health will hold a congress at University College, Liverpool, from July 15 to 21, under the presidency of the Earl of Derby.

The International Congress of Applied Chemistry has adjourned to meet in Rome in 1906.

The *National Geographic Magazine* states that at a conference of representatives from the several geographic societies in the United States, held Saturday, June 20, 1903, in the American Geographical Society Building, 15 West Eighty-first Street, New York city, to arrange for the meeting of the Eighth International Geographic Congress, to be held in this country in 1904, the organization of the committee of arrangements was perfected by the election of Professor W J McGee, of the National Geographic Society, Washington, D. C., chairman, and Dr. J. H. McCormick, secretary. It was formally voted to hold the congress in Washington in September, 1904, adjourning to St. Louis, Missouri, to meet in connection with the International Congress of Arts and Sciences. In addition to the formal sessions of the Congress in Washington, it is planned to hold informal sessions or social meetings in other cities. After the final session in St. Louis, a trip is planned to the City of Mexico, the Grand Canyon, Yosemite Valley, Yellowstone Park, and other points of interest to the members of the congress. The following subcommittees were appointed: *Program,* Mr. C. C. Adams, of the American Geographical Society; *Exhibits,* Mr. Henry G. Bryant, of the Geographical Society of Philadelphia; *Invitations,* Mr. A. L. Rotch, of the Appalachian Mountain Club; *Transportation,* Dr. G. B. Shattuck, of the Geographic Society of Baltimore; *Finance,* Messrs. C. J. Bell, David T. Day and John Joy Edson. The appointment of other committees was deferred till the next meeting of the committee of arrangements. A formal prospectus will be issued in a few days.

The Australasian Association for the Advancement of Science will meet at Dunedin, New Zealand, in January next under the presidency of Professor T. W. E. David, of the University of Sydney, Captain F. W. Hutton, F.R.S., Canterbury Museum, Christchurch, being the retiring president. The sections and their presidents are: A—astronomy, mathematics, physics and mechanics, Professor W. H. Bragg; B—chemistry, Mr. J. Brownlie Henderson; C—geology and mineralogy, Mr. W. H. Twelvetrees; D—biology, Colonel W. V. Legge; E—geography, Pro-

fessor J. W. Gregory, F.R.S.; F—anthropology and philology, Mr. A. W. Howitt; G—(1) social and statistical science, president not yet appointed; G—(2) agriculture, Mr. J. D. Towar; H—architecture, engineering, and mining, Mr. H. Deane; I—sanitary science and hygiene, Dr. Frank Tidswell; J—mental science and education, Mr. John Shirley.

Nature states that in connection with the meeting of the International Meteorological Committee at Southport during the British Association week in September next, it is proposed to make arrangements for an exhibition of meteorological appliances and other objects of meteorological interest. Upon the initiative of the Meteorological Council, with the cooperation of the Royal Meteorological Society and the Scottish Meteorological Society, a committee has been formed to carry out this proposal. It is proposed to group the exhibits into four classes: (*A*) meteorological statistics; (*B*) weather telegraphy; (*C*) atmospheric physics, including (*a*) meteorological photography; (*b*) instruments and instrumental records; (*c*) high level stations, balloons and kites, observations and records; (*d*) experimental illustrations; (*D*) the relation of meteorology to other branches of physics.

The Royal Statistical Society announces that the next competition for the Howard medal will close on June 30, 1904. In addition to the medal, a grant of £20 will be awarded to the writer who may be the successful competitor. The subject is 'The effect, as shown by statistics, of British statutory regulations, directed to the improvement of the hygienic conditions of industrial occupations.'

The Department of Public Improvement of the Mexican government has under consideration the advisability of establishing commercial museums in connection with the more important consulates in foreign countries. Through the efforts of the Mexican consul at Liverpool, England, an exposition of the products of Mexico is about to be inaugurated at that place. The governors of the several states have been requested to forward samples of the principal productions of their respective sections. Precious woods, fibers, cereals, vanilla beans, coffee, sugar, etc., are to be sent at once to the consulate at Liverpool. The Mexican exposition at Milan, Italy, is in complete working order.

We learn from *Nature* that for the first time for about forty years the Royal Society of Edinburgh, on the evening of June 6, held a conversazione. Lord and Lady Kelvin and Sir William Turner received the guests. There were many interesting exhibits from several departments of the Universities of Edinburgh, Glasgow, and St. Andrews, from the Geological Survey of Scotland, the Scottish Antarctic Expedition, etc. Professor McIntosh, of St. Andrews, sent a large collection of pearl shells and animals, living and dead, and great interest was taken in Professor Ewart's exhibition of hybrid ponies. Some of the lantern exhibits were particularly attractive, notably the projection on the screen of tanks of living worms, crustacea, etc., and a fine selection of slides made from Piazzi Smyth's 'cloud' negatives. Among the inventions and novelties exhibited, Dr. Halm's instruments for mechanically correcting stellar observations and for solving Kepler's problem in any given case, and Dr. Hugh Marshall's petrol incandescence lamp are worthy of mention.

Dr. Morris, the Commissioner of the Imperial Department of Agriculture for the West Indies, who has been visiting British Guiana at Mr. Chamberlain's request, addressed a meeting of the members of the Royal Agricultural and Commercial Society of Georgetown on cotton cultivation and other minor industries. With regard to cotton, according to a report from Reuter's agents, he expressed the opinion that at first only light machinery should be introduced for its treatment. Addressing the Board of Agriculture, Dr. Morris expressed his admiration at the great amount of progress which had been made in the colony since he had visited it six years ago. There was evidence of quite a new feeling. Quite a new energy seemed to have taken hold of the leading planters and also the lead-

ing officials. He had not the slightest hesitation in saying that the board of agriculture was doing most excellent work. It was keeping in contact with all classes of the community; it was, fortunately, in sympathy with small cultivators as well as large cultivators. If the people interested themselves in the work of the board and benefited by its advice, he had no doubt that the colony would in a few years be in a very much better position than it was at present. With reference to the sugar-cane experiments, under the direction of Professor Harrison, the commissioner stated that the work carried on was not surpassed in any part of the world where the sugar-cane was cultivated.

UNIVERSITY AND EDUCATIONAL NEWS.

It is said that the trustees of the Rush Medical College, the medical department of the University of Chicago, have collected $1,000,000 for the institution. The newspapers and medical journals state, we hope correctly, that this assures a gift of $6,000,000 to the school by Mr. John D. Rockefeller.

Mr. H. O. Peabody, of Boston, inventor of the rifle that bears his name, has bequeathed the greater part of his estate, which is valued at about $1,000,000, for the establishment of a school for girls, to be situated at Westwood, Mass.

The supreme court of Indiana has decided the Donaldson case in favor of the state. this gives the Indiana University about 200 acres of primitive forest land, abounding in sink holes, valleys and numerous dry and wet caves, including entrance to an underground stream which can be followed for more than a mile and which is the richest locality for blind fishes in North America.

Lord Iveagh has given £34,000 to Dublin University for the erection of laboratories for the physical and natural sciences, on condition that an endowment of £100,000 is provided within three years.

Plans are being urged in London for the establishment of a scientific and technological institute for advanced work. Subscriptions are being secured, and the London County Council has been asked for an annual grant of $150,000.

Mrs. Stern and Mrs. Hardy, daughters of the late Sir George Jessel, formerly master of the rolls and vice-chancellor of the university of London, have offered to present to the university a sum of £2,000 for the establishment, in memory of their father, of a scholarship in law or higher mathematics, to be held at University College.

Appointments at Brown University have been made as follows: Arthur H. Blanchard, assistant professor of civil engineering; Dr. Leonard W. Williams, assistant professor of biology; Dr. Michael X. Sullivan, instructor in chemical physiology; J. Ansell Brooks, instructor in drawing.

Professor William Caldwell, of Northwestern University, has been appointed professor of philosophy at McGill University.

Dr. R. M. Pearce, of Philadelphia, has been appointed director of the Bender Hygienic Laboratory and adjunct professor of pathology and bacteriology in Albany Medical College.

Dr. Raymond H. Pond has been elected professor of botany and pharmacognosy and director of the microscopical laboratories at the Northwestern University.

Dr. John C. Hemmeter, Ph.D. (Johns Hopkins University, 1890), M.D. (University of Maryland, 1885), graduate of the Royal Gymnasium, Wiesbaden, has been elected to the professorship of physiology in the University of Maryland, vice Professor Francis T. Miles, resigned. A new laboratory for physiology and pathology will be erected during the summer for which the sum of $75,000 has been appropriated. Professor Hemmeter has also been elected a regent of the University of Maryland.

Dr. A. F. Dickson, now of University College, Cardiff, has been elected professor of anatomy at Dublin University.

Dr. K. J. V. Orton has been appointed professor of chemistry at the North Wales University College at Bangor.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JULY 17, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE DUTY AND RESPONSIBILITY OF THE UNIVERSITY IN MEDICAL EDUCATION.**

AN experienced railway engineer once told me that when about to establish a grade for a line or railway across a mountain chain he no longer started at the base of the mountain and endeavored to seek a practical ravine or water course through which the line might be led upward to the top of the divide and thence down to the plain below on the farther side of the mountain. He had found from experience that to pursue this course involved him in bad grades and increased difficulties of construction. This method of survey, which lacked a comprehensiveness of plan and breadth of detail so essential to secure the best route, has been abandoned after long trial and by many engineers. His present method was to examine the mountain range first to discover the most feasible passage at the higher level, and when he had once found it he was able to determine with comparative ease the grades required to connect it with the base of the mountain, and could then construct the most practicable and least expensive route.

It is my purpose to-day to urge that medical education be similarly approached from the vantage point of the university with its lofty standards, rather than from a lower point of view, with the hope that

* Annual address to the graduating class in the Yale Medical School, June 23, 1903.

we may be able to perceive more clearly its vital relationship to higher education and its absolute dependence as a growing, progressive science upon the stimulation afforded by university methods, aims and ideals.

To discuss an educational question before university men suggests the appropriateness of the quotation from Confucius with which an eminent scientist once prefaced an address made under similar circumstances: 'Avoid the appearance of evil: do not stoop to tie your shoe in your neighbor's melon patch.' A member of the teaching staff of one of the newest schools of medicine ought to display a degree of modesty in the presence of medical teachers whose thoughts and activities have been molded by the traditions of one of the oldest medical schools in the United States, the sixth in point of time of establishment, and should hesitate above all to urge the duty and responsibility of a university in medical education. I am sure, however, that you will pardon the liberty which I take, for the reason that the relations of medical education to other forms of education and to other parts of the educational system are still unsettled, and it is the privilege, and no less the duty, of all medical teachers to contribute something towards the development of medical teaching from a special and inferior position, until it attains what I believe is to be its final adjustment as one of the highest branches in the general system of university training. Perhaps I may also plead in mitigation of my indiscretion a degree of hereditary relationship to Yale in the fact that my father graduated here in medicine in 1830; my grandfather was a student about 1795, but did not graduate; my great-grandfather graduated in 1778; and my great-great-grandfather in 1739, and may speak as one whose speech can be tolerated because of kin, albeit remote.

In the original development of medicine there was little necessity or opportunity for its scientific study, because the physician was nothing else than a priest. By the access to the gods which his office afforded, and his presumed knowledge of their modes of thought and springs of action, he learned how to influence them, and hence became skilled in the treatment of disease. It was apparently altogether an era of preventive medicine. Disease was universally regarded an evidence of the wrath of an offended deity, and the only way to prevent its ravages was to appease the divine displeasure. If the deity was prevailed upon by prayer or persuaded by sacrifice to hold his destroying hand, disease disappeared. The theory of disease was simple and the methods of cure were obvious. A knowledge of the laws of health and disease was not required. It was only requisite to keep on good terms with the divinity and not to anger him by neglect or sacrilege or presumption. This was the medicine of Moses, of Job, of Homer and of semi-civilized people still the world over.

Later, when the conception of the power and malign influence of the inferior gods of the underworld developed, the physician who had formerly been a priest solely, became in addition a magician and wonder worker to the end that he might overcome the machinations of evil deities by invoking the aid of good deities or compelling the assistance of more powerful and possibly more unscrupulous deities than those who had originally produced the disease from motives of pure malevolence and hatred to mankind. He studied not the law of disease, its mode of manifestation and the remedies which would cure it, but rather sought to ascertain who was responsible for it and what magical rites

and formulæ would counterwork his power. In some instances, in fact, the physician attempted by magic to compel the powers of darkness to act in opposition to each other, and thus, by dividing their power for evil, to rescue the victim of their cruel wrath. Unless the physician's magic influence, or his *orenda,* to use the Indian word given by Powell to express the influence which he thus acquired over deities with mischievous tendencies, was competent to accomplish this result, he was regarded an unsuccessful practitioner and had little fame and less pecuniary reward.

While among many barbarous nations the priest and physician became one and the same, and the physician soon degenerated into a magician and wonder-worker, the conception of disease as a visitation of God has never disappeared, and even now dominates belief and influences conduct. Disease is considered a judgment upon a sinful individual or an erring nation, to be removed by fasting, humiliation and prayer, rather than by remedies and sanitary measures. I have witnessed a day of fasting to arrest the scourge of cholera, and a few days ago I read in a newspaper of the blessing of throats with prayer and candles upon a saint day to prevent the development of diphtheria. Allied to this is also the Christian Science conception of bodily disease as sin, due to a lack of faith in the power and immanence of God. If such conceptions are true, why should we study medicine at all? As students of rational medicine we believe otherwise. At any rate, we do not go to so-called religious teachers to learn the scientific laws of health and disease.

The early conditions of pioneer life in America were not such as to foster the study of medicine. It is true that many well-equipped medical men, educated in England or on the continent, emigrated originally with the colonists and practised the healing art among the early settlers. These men, however, raised up in their turn an inferior class of practitioners through a system of apprenticeship. Apprentices were found in all parts of the country who saw the sick in connection with their preceptors, and thus acquired a degree of familiarity with the aspects of ordinary disease. Opportunities for the study of medicine in the modern sense did not exist. There were no schools of anatomy or facilities for dissection of the human body. A few practitioners after the expiration of their apprenticeship went abroad to Aberdeen, Edinburgh or Leyden, but the majority were prevented by poverty and lack of leisure from availing themselves of these opportunities for medical study. Dr. Welch in a recent address here has called attention to the clerical physicians who flourished in New England, 'those ministers of the soul and comforters of the sick' who did much to keep the spirit of scientific medicine alive but who probably did comparatively little to promote the better study of medicine. They were amateurs rather than physicians. They enjoyed medicine and dabbled in it, but did not live by it. An occasional woman also at this early day bore an honorable part in practical medicine. Ouchterloney, of Louisville, for example, speaks of Mrs. Frances Coomes, of Kentucky, in the middle of the eighteenth century, who was probably the first female physician upon this continent. She was self-taught, but had remarkable vigor of intellect, originality, fertility of resource and strength of character, whose fame as a surgeon, physician and obstetrician extended far beyond the limits of her state. Her operating table was a huge black walnut log, whose upper surface had been rudely smoothed, her instruments were fashioned by herself from domestic cutlery, her ligatures were

obtained from the hides or sinews of deer, and her remedies were the products of the field or the forest about her.

The first attempts at medical instruction in America were made in private schools which supplemented the systems of apprenticeship just mentioned. Cadwallader of Philadelphia, Hunter of Newport, and Shippen of Philadelphia, all in turn gave private demonstrations in anatomy, as this department of study for obvious reasons was inadequately taught under the apprentice and preceptor system. The step from private to public medical schools in connection with existing colleges was soon made. The first, now the University of Pennsylvania, was established as a department of Philadelphia College in 1765; King's College, now the Medical Department of Columbia University, in 1767; Harvard Medical School in 1783; Dartmouth Medical School in 1798; the University of Maryland in 1807; and Yale Medical School in 1813. It is gratifying to note that all these schools were established in connection with well-known and well-established institutions of learning, and were not independent and isolated schools of medicine alone. The movement which brought about the establishment of the Yale Medical School, it should be remarked, came from Yale College, through President Dwight. They were an outgrowth, however, of pioneer conditions and their primary purpose was to furnish medical teaching to supplement the apprentice and preceptor system. They gave courses of lectures on the science of medicine; practical or, rather, clinical work followed under the preceptor. The system was a necessity in a new and undeveloped country, sparsely populated and poorly supplied with medical men. It was a product of American soil, and not an imitation of conditions abroad. These schools were established by well-trained, scholarly men, and the medical instruction given was fully equal to that given in law or theology, where a similar system of preceptors existed. Entrance examinations were required and the same standard of education and fitness exacted as for admission to college. Unhappily this standard of educational requirements so essential to a learned profession was not long maintained. After 1820, and for a half-century and more, medical education steadily retrograded and standards for entrance to medical schools and for graduation were progressively lowered. Schools of medicine upon a commercial rather than an educational foundation sprang up far from centers of population or facilities for clinical teaching, and degrees were conferred upon persons who were manifestly unfit to enter the profession. The majority of these schools were not attached to any institution of learning, or, if nominally attached, they were destitute of any vital connection; they were parasitic growths, like the mistletoe upon the oak, having neither the leaf nor the fruit of its presumptive parent stem. They were founded in every part of the country, and the study of medicine was promoted by one or more short courses of lectures, generally of three or four months' duration, without practical work, too often given to young men of very limited education. The same courses were repeated year after year to the same students, and no difference was recognized between the instruction given to the man about to graduate and the one who had just entered upon the study of medicine. Medical knowledge flowed like the blood-stream in the human body, and every student was supposed to be able to select and to appropriate what was most needed for his growth and mental development. As a witty friend expressed it recently, medical knowledge was pumped

into these students by didactic lectures, to be pumped out again by the final examination. The quantity which was thus 're-covered,' to use a chemical phrase, was sometimes painfully small and generally of little practical value.

In a generally gloomy outlook for adequate medical training a few brighter spots developed. It is gratifying to know that during this whole period Yale Medical School made a strenuous effort to maintain a higher standard. She early exacted a matriculation examination and increased the term of medical study; she inaugurated daily recitations in 1855 to supplement didactic lectures, and established laboratory courses in 1867.

In 1864 Chicago Medical College, now the Medical Department of Northwestern University, graded its course of lectures and made the minimum course three years.

In 1870 Harvard Medical School initiated a similar movement and taught medicine progressively rather than cumulatively. The University of Michigan also extended its course of instruction to three years of nine months each, and made some minor educational requirements for admission. For the most part, however, the preliminary education required was ludicrously inadequate, when one considers that the medical school essayed to fit the individual to enter a learned profession. In some catalogues it was specified that the student should have a knowledge of grammar, orthography, arithmetic and an ability to write a composition of six hundred words. In others it was stipulated that the student should have a high school education and a certificate of good moral character. Whenever any attempt was made to raise the educational standard, pathetic appeals were made successfully in behalf of communities where it was alleged that well-educated physicians could not be maintained or appreciated.

It is doubtful whether this unfortunate state of affairs would have been remedied for many years to come had the initiative been left solely to those who were charged with the responsibility of giving instruction in these so-called medical schools. Fortunately, however, public-spirited medical men were found in almost every state in the Union who insisted that men should not be permitted to practise until they had shown their competency and education by passing an examination before an impartial examining board. This was the beginning of a reform in medical education which dates from about 1890, and which has already changed the aspect of medical schools. The object of medical teaching up to this time had apparently been to fill up the profession by making it easy for every one to enter. The object now seems rather to secure well-trained men with an adequate education.

With the advent of the new era came a minimum standard of educational qualification for entering medical schools, a minimum period of study and a minimum grade of acquirement in order that the graduate of the school might be considered eligible for an examination for a license to practise, all of which were far in advance of what had existed. This has enforced a better preliminary education, a graded course of study, and a higher standard of attainment upon graduation.

It has been said in the past, is now being said, and will be said in the future, as an excuse for poorly equipped physicians, that well-educated physicians are not required in rural districts or where the population is sparse and the people are poor. An early experience in semi-pioneer life convinces me that this is an error. The well-educated physician does not avoid the country, nor does he leave the country for the city after he is once established. The list of eminent medical men who have lived

in the country and still continue to reside there is a long one. Not long ago I had an interview with a physician who resides in a little village in the mountains of North Carolina, and who had gone forty miles to a mountaineer's cabin a few nights before to trephine an incised wound of the skull successfully by the light of a coal-oil lamp, and to remove a knife blade which had been broken off in the wound and which was giving rise to serious and rapidly fatal brain symptoms if relief had not been afforded. He made the diagnosis and performed the operation which snatched the patient from certain death, from his knowledge of cerebral localization. Similar instances of modern knowledge of medicine among country practitioners are frequent. As a matter of fact, the half-educated physician is much more apt to settle in the crowded city than in the country, and the descent into quackery and charlatanism is more easily made there. A good education, I do not say a college degree of necessity, preliminary to the study of medicine is after all the surest safeguard against a misapplication of the knowledge which the physician has acquired.

In the study of medicine we find a combination of technical and theoretical knowledge rarely required by any other profession. The amount of actual knowledge which the student must acquire by an act of memory is truly appalling. I heard not long since of an elderly physician who apologized for his failure to keep pace with the progress of pathology and bacteriology, by reason of his age, but added with pride that he once knew the names of all the bones of the human body. I think every physician may reasonably feel a similar and lasting pride in his feats of memory as a student. The student must know the names, relations and functions of the bones, the arteries, the nerves, the viscera, the nerves of special senses, the brain and spinal cord, and in fact everything about every organ of the human body. He must also know materia medica, pharmacology, chemistry, physiological chemistry, physiology, pathology, bacteriology, hygiene, clinical microscopy and the laws of health and disease. In addition to these branches he must know disease itself in its various manifestations, and learn how to recognize it and how to treat it. In medical study he must cultivate his memory, his powers of observation and his ability to reason from obscure phenomena. He must cultivate his hand to do and his eye to see. While there is still, especially in seeking the causes of disease, much blind groping, medical diagnosis as a whole is no longer an iridescent dream but a growing certainty. Take, as examples of this, malarial fever, tuberculosis, typhoid fever and diphtheria. No one now needs to be long uncertain as to the presence of these diseases, or, if he is, his uncertainty is due to his own lack of training and medical knowledge. And yet I would not be understood as asserting that all the problems of health and disease are equally free from uncertainty. There are difficulties inherent in the factors of the problem which often lead to doubt and uncertainty in the mind of the best trained physician. We can not shut our eyes to the fact that disease is not an entity, an organized enemy of health which attacks the body in a uniform manner, and is to be cast out as a burglar or a midnight intruder is thrust out of your bed-chamber. It is rather the personal reaction of the body of each individual in its own way and in accordance with its own constitution against the morbific agency. The portal by which the same disease enters different individuals may vary widely, the extent of the reaction may vary as widely, and the virulence of the original poison may also vary to an

equal degree. Hence the problems of disease and cure may become most intricate, and over and over again many of the phenomena are in danger of being confused and wrongly interpreted. It has, for example, taken a long time to recognize the fact that the rise of temperature in pneumonia, typhoid fever or tuberculosis is not the disease itself, but merely a symptom of the disease process. Even now we find many physicians whose theory of treatment in these disorders is to combat the rise of temperature by antipyretics, and who honestly think that the patient is cured by subduing what is merely one of the symptoms of the disease. The same was once true of those who thought maniacal excitement was cured by mechanical restraint and by powerful remedies which paralyzed and deprived the patient of his ability to throw himself about. We now know that he was not cured by thus removing the evidence of his disease—in other words, by keeping him quiet—but, on the contrary, his prospects of cure were infinitely lessened by the restraint which the strait-jacket and drug thus imposed upon him.

The demonstration of the presence of a specific organism as the causative factor in the development of many diseases has consequently been a great boon to medicine and has become essential to a proper recognition of the disease and its best mode of treatment. The time may come when the cause of every disease will be equally well known, and to ascertain it is one of the great aims of medical research. Unfortunately, the end is not yet, and in the case of some diseases we must content ourselves with our present half-knowledge.

We now come to the important question: 'How shall medicine be studied?' Here we find ourselves confronted by two theories as to the preliminary training requisite for entering upon such study. On one side we find a strong tendency to shape all preliminary training to prepare the student for medical study. If the preliminary training is to be in a college, we find already in a number of institutions such an arrangement of the course as practically to commence the study of medicine in the third year of the college course and to complete the medical education within two years after graduation from college. In the University of Michigan, Cornell University, the University of Chicago and other similar institutions of high standing this plan has been outlined and will be eventually adopted. Although the bachelor's degree will be considered a preliminary to entering the medical school, the studies of the college will be so combined with those of the medical school as to permit the student to complete his medical course within six years after he has entered college.

On the other side, there is a tendency to divorce the medical education from the college course and to pursue the latter for general culture, irrespective of its bearing upon medical study later. Much may be said in favor of both theories of education. The last-mentioned theory unquestionably presents the broadest view and, if the student has ample leisure, offers the best promise of a true education. It can not be denied, however, that the former view is likely to be more generally adopted and promises to dominate medical education for a time at least. If the student always knew when he entered college that he was to pursue the study of medicine, he might possibly, in these days of elective studies, be able to choose wisely the branches which would best fit him for his subsequent work. In many instances, and perhaps in the majority, the decision to enter the profession grows up slowly and may not be fully attained until he has finished his course of preliminary study. It is altogether probable that he has secured a broader mental

training than if he had contemplated medicine from the commencement of his education and may be equally well fitted to pursue the study, but he finds himself at least one year, and possibly two years, behind his fellow student who had medicine in view from the beginning. For this reason it is probable that the majority of colleges will give elective courses, beginning with the junior year, which will lead immediately to medicine, and that many students will be forced by circumstances to make this early decision.

This hasty and somewhat patience-trying review, I fear, of the circumstances of medical education hitherto in America prepares me now to speak of the duty and responsibility of a university in medical education.

It is apparent that the present requirements for medical education have become so expensive and exacting that schools which have hitherto been maintained as commercial ventures and for the private gain of their owners can no longer be profitable if they honestly seek to do their duty towards the student. Expensive laboratory courses are required in histology, embryology, anatomy, physiology, bacteriology, pathology, clinical microscopy, pharmacology and physiological chemistry. They necessitate much apparatus, many salaried instructors who are precluded by their duties from adding to their income by private practice, and a limitation in the size of the class to permit of personal work. Former methods of medical instruction dealt with students *en masse;* present methods must consider individuals, and the unit of instruction becomes one person instead of five score. If this altered educational condition is to be honestly met by a school which depends upon its fees for its support—and to the credit of many schools, it should be said that they are making the most praiseworthy efforts to meet the requirement—it means a loss of income and an ultimate extinction of the school. With many of them, in fact, the end is not far off. They already suffer from Falstaff's incurable disease—'consumption of the purse.' On the other hand, if the situation is not fully realized and frankly met, we must be prepared to see the commercial school retaining its profits by furnishing insufficient medical instruction and an inadequate training. The medical man is thus fitted, as in the past, to become a practitioner rather than a student and a teacher. To modify a phrase used by another, 'such schools can do something for learners and but little for learning'; in other words, they can help make the doctor, but not the science of medicine.

The present situation, then, demands that schools connected with universities shall perceive the need of the student and protect him from imposition by affording him instruction of a high standard. The university, in fact, must set the standard. The working of the law of supply and demand, it is universally agreed, is no longer adequate to supply the higher education. It must be endowed by individuals or furnished by the state. Individual enterprise and initiative can no longer be depended upon to teach astronomy, the classics, higher mathematics or any other than technical or purely bread-and-butter branches. Medical instruction consequently can not be left to the initiative of the private school any more than can instruction in any other form of higher knowledge. If instruction in medicine is to form part of the university curriculum, the work should be done thoroughly and in such a manner as to add to the dignity of the science. I am aware that, mainly because of the imperfect preliminary education required for admission to the study of medicine, there has always been a query

in the minds of university authorities as to the status of medical science and its claims to be considered a liberal study. The medical student at a university was formerly far from being a matter of pride to his alma mater. His relation to the royal family of letters was apparently a morganatic one. He did not appear on public occasions, was very little in evidence on commencement day, and generally passed without much flourish of trumpets from academic halls to the seclusion of private life. Whatever medical science may have once been in comparison with other sciences, I have no hesitation in saying that now it is the peer of any. Although only the child of the past half century, it can boast of a brilliant series of discoveries. Compare the knowledge which has been acquired of the causation of malaria, yellow fever, tuberculosis, the assured benefits of the diphtheria antitoxin, Haffkine's plague vaccination, Pasteur's anti-rabic inoculation, and the like, with the achievements in any other branch of science. Think of the mental training required to settle the problems of immunity, to investigate questions of bodily metabolism, to know the true action of remedies, and to discover the law of diseases and their mode of cure. Physiology, pathology, hygiene, practical medicine, psychiatry, these are all living branches of medicine which require the highest training which can be given to the human mind to fit it to solve the problems which they present. The medical man needs to know chemistry, biology and physics; he must be trained to use his mind, and to reason from obscure, often imperfectly known, factors. He must be a diligent student of the laws of mind, and keen to observe mental phenomena. Above all, he must have a training of the head and of the heart to fit him for the true exercise of his profession and to deal with problems of the highest importance to the welfare of mankind. Are not such studies worthy the attention of a university, and should not she feel the duty and responsibility of providing adequate teaching for them?

Probably no better illustration could be given of the influence of university ideals upon medical education than is afforded by what has been done in one of the departments of Yale University to promote and develop the study of physiological chemistry. I have no hesitation in saying that the impetus which has been given here to this most important department of chemical study and research has been felt by every medical school worthy the name in America. To Professor Chittenden and the Sheffield Scientific School is due the honor of initiating a most important and heretofore neglected branch of study—one which would probably never have been developed by a school unattached to a university.

The university occupies a vantage ground enjoyed by no mere medical school. She is unselfish, and by reason of her endowment is able to view all educational questions in an unbiased manner, regardless of their effect upon mere numbers of students. She stands for knowledge and truth. She can afford to disregard the mere question of filling up the profession, and need only consider the proper education of competent men. The country suffers from too many medical schools and too many imperfectly educated men. The university is alone competent to limit the production and to improve the quality. The intensely practical studies of the physician, upon the one hand, need the broadening influence of a university atmosphere to bring every branch of science into its proper relations, and to give a proper perspective. The university, upon the other, needs and should foster departments like those of medicine to avoid a

dilettanteism which regards culture as an end and not an adjunct of life. I have sometimes thought that, with the increase of luxury and wealth, and especially with the increase of a leisure class, there has been an increase of those persons who pursue a college course without special purpose or aim. Many of these, in fact, pass through their course without attempting severe study, and are content with the passing joys of an undergraduate existence. Like oarsmen in a boat, they constantly fix their eyes on a receding shore, are satisfied with what they see and do not look in front of them. To such the mental stimulation which comes from university contact with eager, earnest men engaged in branches of medical study which call into keenest activity every faculty, must prove of untold benefit.

Too many medical men reason from case to case as did John Hunter, and frequently these cases are imperfectly observed and inadequately interpreted. The physician needs rather a study of principles deduced from a systematic and painstaking observation of the phenomena of disease and illuminated by scientific conceptions. Already anatomy, physiology, chemistry, bacteriology and pathology are firmly founded upon the scientific method. The practise of medicine and of surgery, pharmacology, food dynamics and bodily metabolism must be similarly based upon scientific deductions. The range of observation required must be wide and the mass of accumulated facts to be gathered for ultimate study must be enormously large. The task of interpreting such observed phenomena calls for the widest training of the human faculty, and where else can this training be secured except in connection with studies of the broadest and most liberalizing character? From every point of view the intellectual aspect of medicine is the most important. To men who have been trained by university studies for research we must look for the future development of medicine. The training of the medical man has been narrow in the past; in future he must draw his inspiration from centers of learning and receive stimulation from his intellectual peers.

A lack of thoroughness is thought by those who are familiar with the educational and industrial development of the world to be a characteristic of the American people. We grasp after results, but are not willing to lay a broad foundation of preliminary education. We have business universities (once commercial colleges), summer universities, correspondence universities and the like, and seek to get knowledge and to secure degrees in the shortest time and with the least possible study. In no profession has this lack of thoroughness wrought so much evil as in the study of medicine.

To you who are to receive the degree of doctor of medicine I offer a hearty word of congratulation, because in the study of medicine it is possible to combine research and practical work, that is, the acquisition of pure knowledge with the application of scientific knowledge to the better care and treatment of sick people. Nothing in my judgment is so stimulating to the student as the possibility of applying scientific knowledge to daily use. I can not speak so positively of other sciences, but I can assert that in the history of medicine it has been found that he who makes the most fruitful discovery is the one who has approached the problem which he attempted to solve through the avenue of practical work. Men who sit down in the privacy of their chambers to make discoveries lack the incentive to produce practical results which comes from actual contact with the outside world and with the hard-and-fast conditions of nature.

Hence whenever I hear complaints on the part of busy practitioners or teachers of medicine that time is absorbed by routine work which in their judgment might be much more profitably spent in research work, I do not always lend a consenting ear to the complaint. I have known many laboratories where teaching was not required which failed to do the work for which they were established. I have known many other laboratories, seemingly overwhelmed by routine work, in which the daily discharge of practical duties led to profound and life-giving discoveries. I would say in passing that it seems to me that under the endowment of research work made by Andrew Carnegie at Washington, the decision not to build a laboratory for special research but to seek out research workers among practical students in the various technical and professional laboratories of the country is eminently wise and philosophical and well calculated to bring larger returns than would be possible in a single laboratory divorced from the every-day practical pursuits of a technical school or university.

For this reason, at least, students who are developed by the smaller colleges are frequently to be congratulated. They become self-reliant, they learn to meet difficulties, they study for love of knowledge and their enforced contact with nature stimulates the scientific sense and makes them productive workers. I have little sympathy too with the study of problems which have no practical value and are mere intellectual gymnastics.

It is not those who have had the most abundant leisure or the best facilities for study who have accomplished the most. Take the historian Parkman with his feeble health, his impaired eyesight and his general state of nervous exhaustion which often permitted no more than five minutes of effective labor each day, and consider how much he accomplished by perseverance and by concentration of purpose and effort. Take Pasteur, not even a physician, yet wrestling mightily and effectively with the problems of disease, handicapped by poverty, paralysis and inadequate laboratory facilities and consider what the world owes to him. Nor do such men belong wholly to the past. All students may draw inspiration and learn humility from a teacher of chemistry at a western university who, deprived wholly of sight by a cruel accident, has had the resolution and fortitude to continue his work as a teacher and investigator, and who has attained scientific results highly creditable to himself and to the institution with which he is connected. The search after scientific truth has the advantage that it does not depend upon externals, but rather upon the intellectual force of the individual; not upon the outward man, but the indwelling spirit.

In your chosen profession be students and productive workers always. Do not look for speedy results and do not be discouraged if the secrets of nature are not wrested from her jealous grasp without a severe struggle. The foundations of our art are broad and deep, and the superstructure should be erected slowly and with care, by accurate observation of disease and painstaking deductions. In your life as physicians be prepared for trials, disappointments and adversities. Take for your motto the words written by Sir Thomas Browne, that eminent physician, more than two centuries ago. "In this virtuous Voyage of thy Life hull not about like the Ark without the use of Rudder, Mast or Sail and bound for no Port. Let not disappointment cause Despondency nor difficulty Despair. Think not that you are Sailing from Lima to Manillia, when you may fasten up the Rudder and sleep before the Wind; but expect rough

Seas, Flaws, and contrary Blasts; and 'tis well if by many cross Tacks and Veerings you arrive at the Port; for we sleep in Lyons Skins in our Progress unto Virtue and we slide not, but climb unto it.''

Have a purpose and carry it out with fortitude. There can be no more absorbing or inspiring career than is afforded by the study of medicine at the present time. The scaffolding reared by countless workers during thousands of years around the fair temple of medicine, necessary for the building doubtless, but concealing its proportions and too often defacing its beauties, has been swept away and for the first time it is permitted to us to know something of the dimensions and architectural possibilities of the completed edifice. Can there be a nobler aspiration for any man than to assist in the completion of the work of transforming the ancient art of healing into the science of medicine?

In my childhood in a far distant state I daily heard from the lips of an aged relative the story of Yale College and New Haven as she had known them at the beginning of the last century. Her tales of the many scholarly activities of the first President Dwight, of the scientific zeal and achievements of the elder Silliman, of the boundless industry in many fields of Noah Webster and of the profound learning and influence of Dr. Æneas Munson, presented ideals of life and possibilities of scholarly attainment which have remained with me ever since. Those who have been engaged in educational work here during the past two centuries can have had no conception of the silent influence which Yale has exerted upon the training of generation after generation of men throughout the whole land who have never visited New Haven nor come into personal contact with the eminent teachers who have gathered here.

Mindful of my own indebtedness to Yale, wholly indirect, I am not guilty of overstatement when I say that I regard the honor of an invitation to address you to-day as the most cherished academic event of my life. I regard the honor, however, in no sense a personal one, but deem it rather an evidence of the good will and amity which has ever characterized the relations between Yale and other schools and teachers. The university with which I am connected and which in a sense I represent to-day is equally her debtor for scholarly inspiration and example, and in her name as well as my own I would render most grateful and appreciative acknowledgment.

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THE NEW DEFINITION OF THE CULTIVATED MAN.*

THE ideal of general cultivation has been one of the standards in education. It is the object of this paper to show that the idea of cultivation in the highly trained human being has undergone substantial changes during the nineteenth century.

I propose to use the term cultivated man in only its good sense—in Emerson's sense. In this paper he is not to be a weak, critical, fastidious creature, vain of a little exclusive information or of an uncommon knack in Latin verse or mathematical logic; he is to be a man of quick perceptions, broad sympathies and wide affinities, responsive but independent, self-reliant but deferential, loving truth and candor but also moderation and proportion, courageous but gentle, not finished but perfecting.

There are two principal differences between the present ideal and that which prevailed at the beginning of the nineteenth century. The horizon of the human intel-

* From the presidential address of Dr. Charles W. Eliot, before the National Educational Association.

lect has widened wonderfully during the past one hundred years, and the scientific method of inquiry has been the means of that widening. The most convinced exponents and advocates of humanism now recognize that science is the 'paramount force of the modern as distinguished from the antique and the mediæval spirit' (John Addington Symonds—'Culture'), and that 'an interpenetration of humanism with science and of science with humanism is the condition of the highest culture.'

Emerson taught that the acquisition of some form of manual skill and the practice of some form of manual labor were essential elements of culture, and this idea has more and more become accepted in the systematic education of youth.

The idea of some sort of bodily excellence was, to be sure, not absent in the old conception of the cultivated man. The gentleman could ride well, dance gracefully and fence with skill, but the modern conception of bodily skill as an element in cultivation is more comprehensive, and includes that habitual contact with the external world which Emerson deemed essential to real culture.

We have become convinced that some intimate, sympathetic acquaintance with the natural objects of the earth and sky adds greatly to the happiness of life, and that this acquaintance should be begun in childhood and be developed all through adolescence and maturity. A brook, a hedgerow or a garden is an inexhaustible teacher of wonder, reverence and love.

The scientists insist to-day on nature study for children, but we teachers ought long ago to have learnt from the poets the value of this element in education. The idea of culture has always included a quick and wide sympathy with men; it should hereafter include sympathy with nature, and particularly with its living forms, a sympathy based on some accurate observation of nature.

We proceed to examine four elements of culture:

Character. The moral sense of the modern world makes character a more important element than it used to be in the ideal of a cultivated man. Now character is formed, as Goethe said, in the 'stream of the world,' not in stillness, or isolation, but in the quick moving tides of the busy world, the world of nature and the world of mankind. To the old idea of culture some knowledge of history was indispensable.

Now, history is a representation of the stream of the world, or of some little portion of that stream, 100, 500, 2,000 years ago. Acquaintance with some part of the present stream ought to be more formative of character, and more instructive as regards external nature and the nature of man, than any partial survey of the stream that was flowing centuries ago.

The rising generation should think hard and feel keenly, just where the men and women who constitute the actual human world are thinking and feeling most today. The panorama of to-day's events is an invaluable and a new means of developing good judgment, good feeling, and the passion for social service, or, in other words, of securing cultivation.

But some one will say the stream of the world is foul. True in part. The stream is what it has been, a mixture of foulness and purity, of meanness and majesty; but it has nourished individual virtue and race civilization. Literature and history are a similar mixture, and yet are the traditional means of culture. Are not the Greek tragedies means of culture? Yet they are full of incest, murder and human sacrifices to lustful and revengeful gods.

Language. A cultivated man should express himself by tongue or pen with some

accuracy and elegance; therefore linguistic training has had great importance in the idea of cultivation. The conditions of the educated world have, however, changed so profoundly since the revival of learning in Italy that our inherited ideas concerning training in language and literature have required large modifications.

In the year 1400 it might have been said with truth that there was but one language of the scholars, the Latin, and but two great literatures, the Hebrew and the Greek. Since that time, however, other great literatures have arisen, the Italian, Spanish, French, German, and, above all, the English, which has become incomparably the most extensive and various and the noblest of literatures.

Under these circumstances it is impossible to maintain that a knowledge of any particular literature is indispensable to culture. When we ask ourselves why a knowledge of literature seems indispensable to the ordinary idea of cultivation, we find no answer except this—that in literature are portrayed all human passions, desires and aspirations, and that acquaintance with these human feelings and with the means of portraying them seems to us essential to culture. The linguistic and literary element in cultivation therefore abides, but has become vastly broader than formerly, so broad, indeed, that selection among its various fields is forced upon every educated youth.

The store of knowledge. The next great element in cultivation to which I ask your attention is acquaintance with some parts of the store of knowledge which humanity in its progress from barbarism has acquired and laid up. This is the prodigious store of recorded, rationalized and systematized discoveries, experiences and ideas—the store which we teachers try to pass on to the rising generation.

The capacity to assimilate this store and improve it in each successive generation is the distinction of the human race over other animals. It is too vast for any man to master, though he had a hundred lives instead of one; and its growth in the nineteenth century was greater than in all the thirty preceding centuries put together. In the eighteenth century a diligent student with strong memory and quick powers of apprehension need not have despaired of mastering a large fraction of this store of knowledge. Long before the end of the nineteenth century such a task had become impossible.

Culture, therefore, can no longer imply a knowledge of everything—not even a little knowledge of everything. It must be content with general knowledge of some things, and a real mastery of some small portion of the human store. Here is a profound modification of the idea of cultivation which the nineteenth century has brought about. What portion or portions of the infinite human store are most proper to the cultivated man? The answer must be—those which enable him, with his individual personal qualities, to deal best and sympathize best with nature and with other human beings.

It is here that the passion for service must fuse with the passion for knowledge. We have learned from nineteenth century experience that there is no field of real knowledge which may not suddenly prove contributory in a high degree to human happiness and the progress of civilization, and therefore acceptable as a worthy element in the truest culture.

Imagination. The only other element in cultivation which time will permit me to treat is the training of the constructive imagination. The imagination is the greatest of human powers, no matter in what field it works—in art or literature, in mechanical invention, in science, government, commerce or religion, and the

training of the imagination is, therefore, far the most important part of education.

I use the term constructive imagination, because that implies the creation or building of a new thing. The sculptor, for example, imagines or conceives the perfect form of a child ten years of age; he has never seen such a thing, for a child perfect in form is never produced; he has seen in different children the elements of perfection, here one and there another. In his imagination, he combines these elements of the perfect form, which he has only seen separated, and from this picture in his mind he carves the stone and in the execution invariably loses his ideal—that is, falls short of it or fails to express it.

Constructive imagination is the great power of the poet, as well as of the artist, and the nineteenth century has convinced us that it is also the great power of the man of science, the investigator and the natural philosopher. The educated world needs to recognize the new varieties of constructive imagination.

Zola, in 'La bête humaine,' contrives that ten persons, all connected with the railroad from Paris to Havre, shall be either murderers or murdered, or both, within eighteen months; and he adds two railroad slaughters criminally procured. The conditions of time and place are ingeniously imagined, and no detail is omitted which can heighten the effect of this homicidal fiction.

Contrast this kind of constructive imagination with the kind which conceived the great wells sunk in the solid rock below Niagara that contain the turbines that drive the dynamos, that generate the electric force that turns thousands of wheels and lights thousands of lamps over hundreds of square miles of adjoining territory; or with the kind which conceives the sending of human thoughts across 3000 miles of stormy sea instantaneously on nothing more substantial than ethereal waves. There is going to be room in the hearts of twentieth century men for a high admiration of these kinds of imagination as well as for that of the poet, artist or dramatist.

It is one lesson of the nineteenth century, then, that in every field of human knowledge the constructive imagination finds play—in literature, in history, in theology, in anthropology, and in the whole field of physical and biological research.

That great century has taught us that, on the whole, the scientific imagination is quite as productive for human service as the literary or poetic imagination. The imagination of Darwin or Pasteur, for example, is as high and productive a form of imagination as that of Dante, of Goethe, or even Shakespeare, if we regard the human uses which result from the exercise of imaginative powers, and mean by human uses not meat and drink, clothes and shelter, but the satisfaction of mental and spiritual needs.

It results from this brief survey that the elements and means of cultivation are much more numerous than they used to be; so that it is not wise to say of any one acquisition or faculty—with it cultivation becomes possible, without it impossible.

The one acquisition may be immense, and yet cultivation may not have been attained. We have met artists who were rude and uncouth, yet possessed a high degree of technical skill and strong powers of imagination. We have seen philanthropists and statesmen whose minds have played on great causes and great affairs, and yet who lacked an accurate use of their mother tongue, and had no historical perspective or background of historical knowledge. We must not expect systematic education to produce multitudes of highly cultivated and symmetrically developed persons; the multitudinous product will always be imperfect, just as there are no perfect trees, animals, flowers or crystals.

Let us as teachers accept no single element or variety of culture as the one essential; let us remember that the best fruits of real culture are an open mind, broad sympathies and respect for all the diverse achievements of the human intellect at whatever stage of development they may be to-day—the stage of fresh discovery, or bold exploration, or complete conquest. The moral elements of the new education are so strong that the new forms of culture are likely to prove themselves quite as productive of morality, high-mindedness and idealism as the old.

Chas. W. Eliot.

SCIENTIFIC BOOKS.

West Indian Madreporarian Polyps. By J. E. Duerden. Memoirs of the National Academy of Sciences, Vol. VIII. 1902.

It may seem strange that notwithstanding the thorough study that has been devoted to the skeleton of the corals our knowledge of their soft parts has been exceedingly limited until recent years. It must be remembered, however, that interest in the anatomy of the nearly related Actiniaria was not really awakened until the publication of Richard Hertwig's report cn the Challenger collection in 1882, and the technical difficulties in the way of extended anatomical study of the coral may well be advanced as an excuse for its neglect.

In the same year that Hertwig's report appeared, however, von Koch laid the foundation for a proper appreciation of the significance of the soft parts of the corals by demonstrating the ectodermal nature of the corallum, and since that date valuable contributions to the anatomy of the Madreporarian polyps have been made by von Koch himself and by Bourne, Fowler and von Heider. The total number of forms studied has, however, remained comparatively small, and although enough information was gained to demonstrate a close similarity of the Madrepores to the Hexactiniæ, yet there was a lack of sufficient data upon which general conclusions could be based. A systematic study of a large number of forms was needed, and this need has recently been supplied by Dr. J. E. Duerden in his paper on the West Indian corals, a paper destined to stand as a landmark in our knowledge of Madreporarian morphology equal in importance to that established by von Koch.

Duerden has made a thorough study of the morphology of no less than twenty-six species of corals belonging to nineteen different genera, and, when the difficulties in the way of such work are properly appreciated, nothing but admiration can be expressed for the patience, perseverance and thoroughness evidenced in every page of his work. It is monographic in its nature, considering in detail the structure, histology and development of the coral polyps as a group, and concluding with full descriptions of the special morphology of the various forms studied.

Dr. Duerden gives good reason for believing that all corals are fundamentally hexamerous, the corallum septa making their appearance symmetrically in embryos already provided with the six pairs of primary mesenteries. In some species the hexamerism becomes much obscured in later stages, while in others it is more or less distinctly preserved; and it has been possible to correlate these differences with the mode of non-sexual reproduction followed by the species. Two principal methods of non-sexual reproduction are recognizable, namely, gemmation and fission. In the former method the mesenteries of the new individual are formed *de novo* and repeat the embryological development, and consequently the hexamerism of those of the parent, while in the latter method half the mesenteries of the parent pass directly to each descendant whose growth processes are limited to an attempt to reproduce the lacking parts, a second fission frequently supervening before the attempt is carried to completion. In the polyps produced by gemmation the mesenteries present the usual hexamerous arrangement, two pairs of directives and at least four additional pairs arranged symmetrically to the

directives being present. But in fissiparous forms, since there is no tendency to reproduce directives in the regenerative growth which succeeds the division, all of the polyps of a colony, with the exception of two, will lack directives and will show little regularity in the arrangement of the mesenterial pairs.

What might be regarded as a third mode of non-sexual reproduction has been observed in the perforate corals *Madrepora* and Porites and has been aptly termed by Duerden *fissiparous gemmation,* since the mesenteries of any one polyp are partly derived directly from the parent and are partly new formations, the process in this respect resembling ordinary fission, while it also resembles gemmation in that the original hexamerous arrangement of the mesenteries and the typical number of directives are retained as a result of growth processes which precede the fission.

The careful study of the madrepores, however, has not yielded such important taxonomic results as might have been expected; their soft parts do not present as much variety as do those of the actinians. But by extending his observations over so great a number of forms Duerden has been able to establish as fundamental certain facts in the morphology of the corals which throw some light upon their position among the Anthozoa. The fact that the corallum appears only after the development of the first cycle of mesenteries seems to warrant the conclusion that the corals are derived from non-coralligenous hexamerous forms. In other words, it indicates that the Hexactiniæ, Zoantheæ and Madreporaria are all traceable to a common hexamerous ancestor, and that after the differentiation of the Zoantheæ the Madrepores and Hexactinians continued together for a time and have for a fundamental distinction only the development or non-development of a corallum. The Madreporaria are merely Hexactiniæ which secrete a corallum. This is by no means a novel view of the relationship of these two groups, but it is one that is emphasized by Dr. Duerden's careful and interesting observations.

But the question whether the derivation of the Madreporaria from the Hexactiniæ is mono- or polyphyletic still lacks a decisive answer. The uniformity of structure shown by the madreporarian polyp seems to argue for a monophyletic origin, although it by no means excludes the other possibility. It is exceedingly interesting to note that of all the actinians, those which approach nearest to the corals in structure are, as Duerden himself has elsewhere pointed out, such forms as *Actinotryx* and *Ricordea,* forms, that is to say, belonging to the stichodactyline group of actinians, having more than one tentacle arising from certain of the endocœlic spaces. And yet such an arrangement of the tentacles is not known to occur among the corals. It would seem either that the corals are derived from actinine forms with regularly cyclical tentacles, and that the similarities which the actinians mentioned above present to them are due to similar conditions of life, the actinians molding themselves over foreign bodies very much as a coral ployp is molded over its corallum, or that we may yet discover stichodactyline corals. So far as our present information goes we are justified in assuming only an actinine origin for the corals, but if, as suggested, the similarities of *Actinotryx* and *Ricordea* to the coral be due to similar life conditions, it would be easy to understand how the formation of a corallum would lead to very general uniformity of structure in forms of different ancestry, and would permit a supposition that the coralligenous forms might have arisen independently from several actinine groups.

A decision on these points must be left for future investigation, which, it is hoped, will be abundantly stimulated by Dr. Duerden's most painstaking and important work.

J. P. McM.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCE.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

THE regular meeting of the section was held on April 27 in conjunction with the New York branch of the American Psycho-

logical Association, Professor Thorndike presiding.

Professor E. L. Thorndike reported the results of extended measurements of mental traits in the two sexes. In general the females were less variable. In the case of children 9 to 12 the ratio of female to male variability was .92; in the case of children 13 and 14 it was 1.02; in the case of children 15 it was .97; in high school pupils .95; in college students .85. In the abilities measured the greatest difference found was the female superiority in the tests of impressibility, such as the rate and accuracy of perception, verbal memory and spelling. In these only about one third of the boys reach the median mark for girls.

Mr. Wm. Harper Davis read 'A Preliminary Report of Tests of Scientific Men,' dealing with some twenty physical and mental measurements made upon one hundred professional men of science, under the auspices of the Committee on Anthropology of the American Association for the Advancement of Science. No significant correlations were found between any of the tests and the several departments of scientific activity, although the cases were too few to warrant an expectation of decided results. (The superiority of psychologists in 'logical memory' was attributed to the accident that the passage used in the tests was psychological in content.) Vivid mental imagery was less common among the older than among the younger men. Two cases of color-blindness were detected.

Comparison with Columbia College students, upon whom the same measurements have been made, revealed no significant difference between the two groups, except such as would naturally arise from their disparity in age.

Critical comments were made on some of the tests and on the method of administering them. It is expected that these measurements will be continued under the direction of Professor J. McK. Cattell, who is engaged upon a comparative study of scientific men.

Mr. S. C. Parker presented a paper upon 'Correlation of School Abilities.' Several investigations in Teachers College have had for their subject 'The Correlation of School Marks.' The method and results of these researches are set forth in Vol. XI., No. 2, of the 'Columbia University Contributions to Philosophy, Psychology and Education.' This paper reports the results of some new calculations based on the marks of 245 boys in a New York City high school.

It must be borne in mind that we do not know exactly what school marks represent; they may represent real ability in the school subjects or merely the ability to get marks.

In performing the statistical work, it is important to transmute each teacher's marks separately. This point is mentioned because the neglect of it by one investigator lays his results open to question.

There is not any very great variation in the correlations between marks in academic subjects, such as the languages, sciences and mathematics. The Pearson coefficients run between 40 per cent. and 60 per cent. The correlations of drawing with academic subjects are low—lying as a rule between 0 and 25 per cent. From a psychological standpoint, the academic correlations are high. But it must be borne in mind that many constant errors enter in which would make the correlations much higher than the essential relationships would be. From an educational standpoint the correlations are low. They show the futility of the belief in general brightness for all things, and are one of the best arguments for the elective system.

Professor MacDougall read a paper on 'The Specialization of the Hand in Relation to Mental Development.'

James E. Lough,
Secretary.

ENTOMOLOGICAL SOCIETY OF WASHINGTON.

The 177th regular meeting was held on April 2, 1903, nineteen members and one visitor present.

Mr. Banks reported that eleven members attended the field excursions to Bladensburg, Md., on March 26. A most enjoyable day was spent and some good specimens secured.

Dr. Dyar read 'A Note on *Pyrausta ochosalis* Fitch MS.,' a pyralid moth, showing that Fitch's species is distinct from *Pyrausta generosa* G. & R. He exhibited, further, a living larva of *Hemileuca electra* Wright, from southern California, one of the rarest of our saturnian moths. Dr. Dyar presented, also, a description of a new genus and species of moths belonging to the family Tortricidæ.

Mr. Ashmead exhibited a ceropalid (pompilid) wasp taken in Texas in the nest of the harvesting ant, *Pogonomyrmex barbatus* Smith. It constitutes a new genus and species.

Mr. Warner showed a proctotrypoid hymenopterous parasite found attached by its jaws to a specimen of grasshopper in the National Museum collection. It is a species of the genus *Scelio,* the members of which are parasites of grasshoppers' eggs, and have a habit of attaching themselves to gravid female grasshoppers and waiting for them to oviposit.

Dr. Hopkins reported some observations he had made recently in North Carolina upon (1) certain dipterous galls found on pine at Asheville, and (2) the damage inflicted upon girdled cypresses, sweet gums and black gums by ambrosia beetles.

Mr. Heidemann exhibited a specimen of the aradid bug, *Neuroctenus pseudonemus* Bergroth, collected at Bladensburg, Md., under bark, and not previously recorded from the vicinity of the District of Columbia.

Mr. Banks showed a specimen of the syrphid fly, *Ceria willistonii* Kahl, reared from the puparium at East End, Virginia. It is new to that locality. The adult resembles a fly of the family Conopidæ, or some wasp. He exhibited, also, two rare ortalid flies which resemble ants in appearance, *Myrmecomyia myrmecoides* Loew and *Odontomera ferruginea* Macquart.

Dr. Howard described some recent experiments carried on in Brazil for the purpose of testing the correctness of the conclusions of the U. S. Army Commission in regard to yellow fever. These experiments have been generally accepted as conclusive, and have removed all incredulity as to the fact that mosquitoes play a part in the transmission of yellow fever.

The following papers were presented: 'A Revision of the Boreal-American Species of *Nonagria* Ochs,' a genus of noctuid moths, by John B. Smith; 'Some Remarks on Genera in the Mutillidæ' (sand wasps), by William H. Ashmead; 'A Review of the North American Species of the Lepidopterous Family Anthroceridæ' (Zygænidæ), by Harrison G. Dyar.

ROLLA P. CURRIE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

THE GRAND GULF FORMATION.

TO THE EDITOR OF SCIENCE: In response to the clear and courteous exposition of their present ideas of what constitutes the Grand Gulf formation, by Messrs. Smith and Aldrich (SCIENCE, July 3, pp. 20–26), I may say: (1) That I withdraw the opinion that it is not new; now that I understand it clearly, I regard it as an absolutely new view; (2) that so far as observed facts are concerned I am far from wishing to be understood as questioning the existence of a deposit of unfossiliferous clay which contains irrecognizable traces of vegetable matter, which has a wide distribution as claimed by these gentlemen, and lies above the Chesapeake Miocene and below the so-called Lafayette, from which it is not separated, where I have observed it, by any unconformity or characteristic peculiarity. I would recall the fact that I have personally no knowledge of the 'Grand Gulf' except what I have derived from such excellent authorities as Wailes, Hilgard, Smith, Langdon, Professor G. D. Harris, Miss Maury, etc., from their published writings and observations in the field. My office has been, after making field studies of the fossiliferous Tertiary, especially the Chattahoochee and Chipola sections, to endeavor to correlate with horizons of known age in the marine series, the fresh- or brackish-water formations almost destitute of fossils, laid down about the margin of the Mississippi embayment during a long period of Tertiary time, which have been named by the geologists above mentioned, and to which, so far, no satisfactory key has been found.

The difference of opinion, therefore, between Messrs. Smith and Aldrich and myself is in regard to *names* and their application merely, and not a calling in question of the accuracy of any observation made by them.

It is an acknowledged fact, I believe, that at least since the period of the Vicksburg sedimentation, a considerable part of the shores of the Mississippi embayment have been and still to some extent are the seat of a sedimentation of alluvial material in fresh or brackish water containing fragments of vegetable matter converted into lignite, and from which only a few rare specimens of freshwater molluscan fossils, turtle shells, etc., have been obtained in half a century. The rarity of fresh-water shells is proof that the marshes or lagoons could not have been purely fresh-water areas, the absence of oysters, etc., shows that they were not permanently brackish, and we are forced to offer the hypothesis that fresh and salt water so alternated over the area concerned, that inhabitants of neither were able to maintain a footing and that the organic remains found are either drifted from elsewhere or the product of extremely local and temporary conditions.

The earlier deposits of this kind, other things being equal, we should expect to, and I believe we do find at the greatest distance from the sea and in the most consolidated state; though a comparatively recent transgression has carried unconsolidated sediments over a large part if not all of the antecedent deposits. Now it seems to me that in their interesting communication Messrs. Smith and Aldrich have momentarily forgotten the history of research on this perplexing question. Let us very briefly review it.

The Grand Gulf sandstone, a rock 'superior in hardness to granite itself' was first named by Wailes in 1854, who specifies as a typical exposure that on the banks of the Mississippi, at Grand Gulf, Claiborne Co., Miss., from which the formation was named. Hence in the allocation of names to portions of the sediments which have since been hastily included under it, we must reserve for this particular horizon the name of Grand Gulf. Wailes believed that more tractable rocks to the eastward were identical with this sandstone, but everywhere it is described by him as a rock, a hard or massive sandstone, suitable in its softer phases for building stone, millstones, etc. Beyond the Mississippi this sandstone reappears in Louisiana, and according to Miss Maury extends across the state and as far as the Brazos River in Texas. To the eastward near Oak Grove, Florida, the typical sandstones according to Professor Harris and Miss Maury 'pass beneath the (Oligocene) Oak Grove sands, indicating that the sandstone is approximately of the same age as the Chattahoochee.'* In Alabama the typical sandstone is rare and the series corresponding 'usually consists of clayey sands or joint clays' according to the same authority.

In 1860 Hilgard, in his valuable report on the 'Agriculture and Geology of Mississippi,' considerably enlarged the scope of the formation, taking in clays, sands, consolidated and unconsolidated, over a large area of country. Later, as mentioned in my last communication, he came to the conclusion that the series included a succession of sediments of ages between the Vicksburg and the drift. The fact that at the typical locality the flinty sandstone is succeeded by the unconsolidated Lafayette or Orange Sand, is of course no evidence of continuous sedimentation without a break between the two, such as appears to be the case in the aluminous clay of the Chattahoochee, where no distinct line of demarcation is visible between the latter and the so-called Lafayette conformably above it.

As one of the problems to be solved this state of things has long attracted the attention of the few geologists working on the southern Tertiary. Some fifteen years ago I received from Professor Smith what were hailed as fossils at last from the Grand Gulf sands of Roberts, Ala., a horizon which in 1894 Professor Smith included in the Grand Gulf formation.† They were very imperfect but fortunately contained one identifiable characteristic Oligocene species of the Chipola horizon. Subsequently Mr. L. C. Johnson obtained from what he pronounced to be

* *Bull. Am. Pal.*, No. 15, p. 70, 1902.

† 'Coastal Plain of Alabama,' p. 102.

Grand Gulf strata near Vernal, Miss., another series of fossils which I was able to determine as of late Chesapeake or early Pliocene age, and which were then eliminated from the so-called Grand Gulf and placed by Professor Smith at the top of the Miocene with the name of the Pascagoula formation (*op. cit.*, p. 94).

In 1894 Professor Smith expressed himself in regard to the 'Grand Gulf' in the following language: 'The barren Grand Gulf sands pass towards the east into the marine deposits of the Chattahoochee (Oligocene) which are their time equivalent' (*op. cit.*, p. 17) and 'The underlying division of the Grand Gulf * * * its position is identical with that of the Chattahoochee limestone of Mr. Langdon, and there is no room for any reasonable doubt about their identity in age' (*op. cit.*, p. 106).

Since that time Professor Harris and his party of students have traced typical 'Grand Gulf' sandstones beneath the Oak Grove Oligocene sands near Oak Grove, Santa Rosa County, Florida, as already mentioned.

I have no prejudice as to the application of the name Grand Gulf to any particular series to which it can be shown to belong, but I am not convinced that Professor Smith and Mr. Aldrich, in restricting the name in the manner and to the stratum now proposed, have shown proof of its identity with the original formation described by Wailes. I feel certain that the Pleistocene age of Wailes' formation is unproved. I believe it to be unlikely, and, in view of the record as above summarized, I feel justified in referring it, as heretofore, to the upper Oligocene, pending more exact and ample information.

WM. H. DALL.

SMITHSONIAN INSTITUTION,
July 6, 1903.

ANSWER TO PROFESSOR COCKERELL, REGARDING HIGHER EDUCATIONAL INSTITUTIONS OF NEW MEXICO.

TO THE EDITOR OF SCIENCE: Professor T. D. A. Cockerell has made some statements in his article on the condition of affairs at the New Mexico Normal University which appeared in your columns May 8, which seem to me can hardly be passed without notice. I do not care to discuss the matter which Professor Cockerell presents concerning the conditions at the College of Agriculture and Mechanic Arts or at the Normal School at Las Vegas. It is always unfortunate when there is a lack of harmonious relations between a board of regents and the president or faculty of any institution, and still more unfortunate when such relations are the result of political influences. There is no doubt but at times great injustice results to individuals and great harm to the institution and the broader cause of education. Few institutions of any considerable age have not had some differences arise between their managing boards and their faculties at some time in their history, and no institution can boast that its organization is such that it is entirely safeguarded against any such unfortunate condition in the future. It must be recognized, however, that such breaches in the harmonious administration of the affairs of an institution are usually very short-lived. The organization of our public institutions may be such that they are more susceptible to such outbreaks than others, but it is to be doubted. In the public institution it is usually politics which interferes; in private institutions it is personal prejudice; in denominational schools it is denominational creed or religious difference. The character of the factor may vary, but the result is nearly the same. In all such cases it can usually be shown that some one has abused the powers and privileges of a position of authority. In public institutions all parties, from the governor, who usually holds the appointing power to membership on the board of regents, down to the student in the class-room, are servants of the people, and all are working under a regularly established system of laws. These laws determine the authoritative ranking of each. Each party has a duty to the subordinate elements of the organization, and an obligation of obedience to the superior in rank. In most institutions these duties and obligations are usually well defined by law.

In passing judgment upon any particular case these broad relations should be kept in mind, and in what I have to say I do not wish to be understood as expressing any opinion concerning the conditions which have existed at the Agricultural College in the past, or at the Normal School at the present time. There are, however, two points in Professor Cockerell's communication to which I desire to call especial attention. Not that the professor has intentionally misrepresented the matter, but because of the inference which might easily be drawn. The conditions in two of the several public institutions of the territory are made the basis of several broad and general inferences. I am assured by President Light of the Normal School of Silver City that the relations of the board of regents of that institution and the faculty have been uniformly harmonious, and that the institution is wholly free from political influences in its administration. Professor Cockerell states in his article that the Normal School at Las Vegas '*has had until now a most fortunate immunity from political interference*.' And I wish to state that it has never been my pleasure to know of a public institution so free from political influences as the University of New Mexico, over which I have the honor to preside.

Again, Professor Cockerell says: 'It can not be overlooked that the governors of New Mexico, who appoint the regents of the higher institutions, are responsible for the general unsatisfactory character of these bodies.' I wish to object to the professor's use of the term 'general' and 'these bodies,' and to state that, at least in the case of the University of New Mexico, a more estimable body of men could not be selected from any community either in this territory or any of the eastern states of the Union.

Hon. Ex-Governor E. S. Stover has always been a staunch friend of education. Hon. F. W. Clancy is one of the old and leading attorneys of the city of Albuquerque. Dr. James H. Wroth is one of the leading physicians of the city and surgeon for the Santa Fe Railroad. Hon. Henry L. Waldo, of Las Vegas, is general solicitor for the Santa Fe Railroad and ex-chief justice; and Hon. E. V. Chavez is another of the leading attorneys of Albuquerque. There are three Democrats and two Republicans. These men are all appointees of governors of New Mexico, and three of them originally by Governor Otero, and all have been reappointed by him at the expiration of their terms.

As to the other institutions of the territory, I can only say that their boards, as far as I know, are made up of men who are leading and influential citizens.

In closing, permit me to say that, in my judgment, the higher institutions of learning of the territory of New Mexico are in general fully as free from political influences as are those of any other state of our Union, and it is hardly right to take the exceptional unfortunate cases of disorder as indicative of the general condition.

W. G. Tight.

University of New Mexico,
Albuquerque, N. M.

THE PROPOSED BIOLOGICAL STATIONS AT THE TORTUGAS.

To the Editor of Science: Referring to the correspondence from zoologists as to the need for one or more stations for biological research work in southern waters, I notice the preponderance in favor of Tortugas. Aside from its suitability for deep-sea fauna there seem to be other items to commend it, such as: The flag which floats over it, available buildings, subsistence, accessibility and, not the least in importance, communication. It may not be known to the committee or to your readers that the United States government departments are planning a chain of wireless telegraphic communication along the coast and to the Antilles. Among those now installed are stations of the De Forest Company at Hatteras and Porto Rico; others are proposed at Miami, Key West, Havana, etc. These will be in demand for commercial marine as well as naval and military purposes.

A glance at the map will show that Tortugas can easily be hitched on to this system *viâ* Key West (and equally a station at Cul-

ebra *viâ* San Juan) with very little added cost or trouble. No cable will be required, but only a mast and some sort of light motor. The operator could be improvised easily by one of the resident staff familiar with the Morse code. The greater comfort and convenience of life with this facility at hand would be cheaply purchased.

I am assured by the executive of the American De Forest Company—whose office is at 100 Broadway—that they would welcome the establishment of a science station near their field and cooperate in any reasonable way for the handling of any commercial business that might come that way.

Believing that this suggestion may have further weight in the deliberations, I forward this with the concurrence of Dr. De Forest's organization. R. T. COLBURN.

ROOM C, 120 BROADWAY, NEW YORK.

SHORTER ARTICLES.

SOME OF THE DANGERS OF FORMAL.

So much use is being made of formal* in the conservation of anatomical and zoological specimens, as well as for purposes of disinfection, and it has become so readily accessible to persons unfamiliar with some of its dangerous properties, that it may not be amiss to point out some of these. Of course every one who works with formal has experienced the disagreeable coryza and coughing arising from the inhalation of the fumes of this drug, as well as the irritating effect upon the ocular conjunctivæ. Although no fatal case of poisoning by inhalation has been recorded, one may take warning from the experimental results of M. H. Fisher,† who found that the exposure of various animals (guinea-pigs, rats, cat and dog) to the fumes of formaldehyd for one or one and a half hours produced in them a fatal pneumonia, tracheitis and bronchitis, after only three grams of paraformaldehyd had been volatilized in the room. Only recently, in this city (New York) a woman was overcome by formal fumes. Her younger child had had diphtheria; the disinfecting was done in the afternoon and the family moved in again about seven o'clock. The odor was still strong, but the woman thought it would pass away and went to bed. Later she awoke with her head ringing, and was just able to crawl to the hall and summon help. The children were not ill at all. The writer has noticed in himself, after working in an atmosphere fairly charged with formal fumes, a state of depression and dulness which does not wear off until after spending some time in fresh air. A long exposure might bring about a serious condition, though Kenyon* expresses it as his belief that the vapor does not endanger inhabitants of rooms, and cites an experiment on a calf kept in an atmosphere of two per cent. formaldehyd for five hours, which only produced a slight cough and some watering of the eyes, both symptoms disappearing on the animal's going into fresh air.

The effect of formal on the skin is well known.† The cuticle is killed; it hardens, cracks and desquamates; in some individuals this is attended by an eczematous rash. The nerve terminals in the skin are paralyzed, producing an annoying numbness. Where the skin is cracked, the entrance of formal becomes very painful.

The palpable influence of formal on the glandular action of the skin led Dr. E. C. Spitzka to recommend it in two instances where patients consulting him mentioned their being affected with the annoying condition of perspiring hands and feet. They began with a dilute solution used as a wash several times a day, and gradually increasing its strength, not exceeding one of ten per cent. of the commercial preparation. In both cases the effect was gratifying after two or three weeks, and in one of them the permanency of the cure seems guaranteed by the non-return of the trouble for three years thereafter.

To laboratory workers one of the great dangers is the accidental splashing of drops

* On the use of *formal* as a term more suitable than *formalin*, *formol* or *formalose*, cf. B. B. Stroud's papers in *The American Naturalist*, January 1 and May 1, 1897.

† M. H. Fischer, 'The Toxic Effects of Formaldehyd and Formalin,' *Jour. of the Boston Soc. of Med. Sci.*, Vol. 1, October 16, 1900.

* F. C. Kenyon, SCIENCE, VI., 1897, p. 737.

† W. H. Dall, SCIENCE, VI., 1897, p. 633.

of formal into the eye. This occurred once to the writer, and the experience was certainly the most intensely painful in his recollection. Fortunately, the affected eye could be bathed almost immediately with a stream of running water and the irritant had not hit the cornea, else this transparent portion of the external tunic of the eye would undoubtedly have been rendered more or less opaque. Where the irritant had come in direct contact with the ocular conjunctiva, an almost immediate and intense congestion appeared, accompanied for several hours by an exquisite pain. In Fischer's experimentation on animals it was determined that a single drop of the concentrated solution introduced into the conjunctival sac is sufficient permanently to injure the eye. A contraction of the pupil to pinhole size follows, and atropine fails to dilate it again.

The toxic effects of formal which is accidentally swallowed are so profound that a timely word of warning may not be uncalled for. Medical literature contains quite a number of cases, of which the following brief accounts will convey some idea.

(*a*) Bock* reports the case of an inmate of the Indian School for Feeble-minded Youth, aged twenty-six, strong and healthy, who took, while unobserved, about two ounces of concentrated formal. There was early vomiting with traces of blood; collapse and unconsciousness ensued; heart-failure occurred after sixteen hours, and drugs failing to stimulate the depressed vital functions, the patient died in twenty-six hours. A post-mortem examination showed the stomach to be highly inflamed, necrotic and œdematous, and containing about four ounces of dark fluid.

(*b*) Klüber† had a patient who took a draught from a bottle labeled 'Apenta' water, which he afterwards described as 'tasting like gall.' The patient became unconscious, passing into a state resembling that of alcoholic intoxication or of a post-epileptic condition; the urine was suppressed for nineteen hours, and when it appeared was scant and gave the reaction for formic acid. He recovered in a few days, owing to the prompt and careful treatment.

* C. Bock, *Indiana Medical Jour.*, XVIII, 1899–1900, p. 122.

† Klüber, *Münch. med. Wochnschr.*, 1900, p. 1416.

(*c*) Zorn* describes the case of a porter, aged forty-four, who swallowed about half the contents of a medicinal glass of 30 c.c. capacity, in the belief that he was taking 'Hoffmannstropfen.' The burning taste made him aware of his mistake and he swallowed some milk. This was followed by terrible retching and vomiting, then unconsciousness. The pulse and respiration rose rapidly in frequency, the temperature fell, and the urine was suppressed for twenty-four hours. Other symptoms pointed to a parenchymatous irritation of the kidneys and of the gastro-intestinal tract.

(*d*) Gerlach† had a patient, a servant girl, aged twenty-one, for whom he had prescribed (*a*) formal mouth-washes and (*b*) a solution of potassium iodide, in the treatment of thrush (stomatitis). The two bottles stood near each other, and the girl, on retiring, mistaking one for the other, took nearly 60 to 70 c.c. of the concentrated formal. Unconsciousness, collapse, etc., ensued, and only the prompt emptying of her stomach by the physician averted a fatal ending of the case. Anuria persisted for twelve hours.

(*e*) Testi‡ reports the case of a man who by mistake swallowed a mouthful of a forty per cent. solution of formaldehyd. The chief symptoms were intense pain after swallowing, followed by vomiting, intense congestion of the face, conjunctivæ, fauces and tonsils. For two or three days his condition remained unchanged; he was unable to swallow anything but the smallest quantity of liquid. Two large eschars formed on the fauces and tonsils. Unlike most of the cases cited above, there was no general stupor, anuria or the modifications of pulse, temperature and respiration, which may be accounted for upon the ground that the prompt vomiting prevented absorption of the poison into the system, its effect being purely local.

* Zorn, *Münch. med. Wochnschr.*, 1900, p. 1588.

† Gerlach, *Münch. med. Wochnschr.*, 1902, p. 1503.

‡ Testi, *Il Policlinico*, IX., 8, December 20, 1902.

The effect of even minute quantities, such as the dairymen began to employ in the preservation of milk (1:20,000), has been shown to be a harmful one, in the long run, at all events. Whether this is due to its influence on the proteids of the milk or upon the enzymes of the digestive tract, is not rendered quite clear as yet, but that digestion is interfered with, particularly the pancreatic digestion of albumen, is determined with certainty.

The above enumeration of some of the dangers of formal shows that the accidental swallowing of the drug is perhaps the greatest, particularly as the outcome of any case differs very much in different individuals and under different circumstances. Even the prompt medical aid given in the first case cited above failed to avert death, and the careful guarding of this drug from coming into the hands of the inexperienced or the irresponsible devolves upon every one in charge of laboratories, factories, farms, hospitals and other places where formal is used. Every bottle or other receptacle containing formal should be distinctly labelled 'POISON.' A few words, in conclusion, on the initial treatment of a case of acute formal poisoning may be found useful. The strong affinity of formaldehyd for ammonia gives a hint of therapeutic value.* The aromatic spirits of ammonia in doses of from one half to two fluid drachms, or even somewhat more, according to the amount of formal swallowed; or the liquor ammonii acetatis (spirit of Mindererus) in half-ounce doses, should be taken immediately as an antidote for the local effects. A physician should, of course, be sent for. Vomiting should be promoted, and the stomach washed out several times through a tube. The constitutional symptoms of depression of the vital functions must be met by the use of stimulants such as strychnine or caffeine. The patient must remain in the recumbent position, and external heat, by means of hot-water bottles, or by frequent lukewarm baths, should be applied. Demulcent drinks in small quantities frequently given allay the irritation. Food can not be taken for some time.

E. A. SPITZKA.

* Bastedo, article, 'Formaldehyd,' in 'Buck's Ref. Handbook of the Medical Sciences,' 1902.

QUOTATIONS.

THE AMERICAN METHOD OF APPOINTING UNIVERSITY PROFESSORS.*

I AM wrestling at the moment with a mass of correspondence which has accumulated during an eighteen weeks' absence in America. Among the letters demanding my immediate attention are several from friends requesting 'testimonials' regarding their fitness to fill professorships which are now vacant. These applications bring into sharp relief important differences between the old country and the new, in point of academic etiquette or custom. I think that the principle involved is a matter of public concern. The superiority of the new country's practice in the matter of appointing academic officers is, to my mind, so manifest that I am sanguine enough to believe that dissemination of knowledge about the newer system will lead at no distant date to the abrogation of the older.

In America I visited a score of the leading universities, including such veteran foundations as Harvard, Yale and Princeton, and such modern institutions as Johns Hopkins, Cornell and Chicago. Among many other topics which I discussed with university presidents and professors of standing was the mode in which vacancies in the various faculties were supplied. The method in universal vogue on the other side of the Atlantic is entirely unlike the usage familiar on this side, though there are resemblances between the American method and that employed by ministers of the crown in nominating regius professors.

Appointments to all vacant offices in an American university are made by the president, on what may be regarded for practical purposes as his sole authority or responsibility. (At the same time the president's action is always liable to control or check by boards of trustees or regents, who are usually sagacious men of position in the professions or in commerce.) As soon as a vacancy arises in

* From the London *Times*.

the professorial staff, the president consults members of the faculty concerned. He invites their opinion as to who is the fittest man to fill the vacant chair. But the president does not confine his inquiries to his immediate circle of colleagues. University presidents and professors in America constitute almost a caste of their own. By virtue of well-organized clubs and associations, which cover the great continent like a network, they keep closely in touch one with another. Knowledge of the reputations that men are acquiring in academic work is wonderfully well diffused. The president who is seeking to fill a vacant chair has at command ready means of communication with presidents and professors of other universities. He is usually in correspondence with foreign scholars and teachers. He neglects no opportunity of collecting evidence as to the qualifications of professors, assistant professors and instructors in various parts of his own country. Finally, after due and thorough investigation, he forms his decision as to how the vacant post may be filled with greatest advantage to the institution over which he presides. He forwards an invitation to the chosen person to occupy the vacant office. The wisdom of his choice is rarely, if ever, questioned.

At every stage the election is the antithesis of a public contest. There are no self-nominated candidates. Consequently no one is defeated and no one triumphs over another. Everybody's feelings are scrupulously respected. The preliminary inquiries are pursued in the strictest confidence. Most important of all, no open advertisement on the part of either elector or elected is permitted. Every American professor with whom I spoke on the subject deemed it an intolerable strain on a scholar's proper modesty to require him to nominate himself for election, to describe his own attainments, to print a statement of his qualifications for a vacant office. Still more repugnant to the American code of academic ethics is it for a would-be professor to invite his acquaintances to eulogize his character or his writings with a view to circulating 'testimonials' in printed pamphlets. Such conduct is generally held in the United States to be ignominious. Testimonial-hunting, as it is pursued in this country would prove a fatal bar there to promotion of any reputable kind.

The only argument that I have heard advanced in favor of the British system, whereby everybody is at liberty to offer himself for election for a vacant professorship, to declare his own merits, and to solicit confirmatory compliments from his friends, is that the elector's field of choice is thus usefully enlarged. But this argument is open to most serious question. Men of ordinary sensitiveness often refuse to submit themselves to the humiliating ordeal of public or semi-public competition for a vacant professorship, which in many respects reduces them to the level of advertising vendors of quack medicines. In effect the prevailing system often narrows the field of choice open to the electors, who are not in the habit of looking outside the panel of self-appointed candidates; it is, indeed, doubtful if honorable regard for the terms of their public advertisement permit them such a course of action.

It ought to be an easy matter for the heads of colleges and universities in Great Britain to adapt the American method to home requirements. The difficulties incident to the enormous area and population of the United States and to the vast and increasing number of academic institutions which are worthy of consideration there, are not present in this country. To pronounce the American system unworkable here is a confession of inferiority, from the point of view alike of ethics and practical efficiency, about which one would prefer to be silent.

Sidney Lee.

108 Lexham-gardens, W.,
June 3, 1903.

CURRENT NOTES ON METEOROLOGY.

THE CLIMATE OF BENGUET, PHILIPPINE ISLANDS.

"There is no region in the United States which has a more healthful or delightful climate than is afforded by the Benguet highlands, where a white man can perform heavy field labor without excessive fatigue or in-

jury to his health" (*Nat. Geogr. Mag.*, May, p. 203). "Great province. This is only 150 miles from Manila, with air as bracing as Adirondacks or Murray Bay. Only pines and grass lands. Temperature this hottest month in the Philippines in my cottage porch at three in the afternoon, 68° F. Fires are necessary night and morning" (Cablegram from Governor Taft to the Secretary of War, dated April 15). These are two recently published statements regarding the climate of the highlands of Benguet, in the northern part of the island of Luzon. Such broad general statements are misleading. They tend to spread false notions regarding the possibility of the acclimatization of the white race in the Philippines, and of outdoor work by white men in a tropical climate. Altitude, as in the highlands of Benguet, or of India, gives some relief in the way of lower temperature than at sea level. It means the absence of some tropical diseases which prevail on the lowlands, or a more rapid recovery from these diseases than at sea level. But all experience shows that altitude does not solve the acclimatization problem. A tropical sun is always a tropical sun. A tropical climate is always a tropical climate. It should be the aim of all Americans who send us accounts of Philippine climates, avoiding generalities based on first impressions, carefully to study the effects of the climate upon white men. The experience of English, French, Germans and others in the tropics furnishes evidence enough of the inaccuracy of much that has been written of the climate of the Philippines.

THE RECENT FLOODS.

THE disastrous floods of March, April and June on the Mississippi and Missouri Rivers naturally attracted much attention in the daily papers. Along the lower Mississippi River the March-April flood of the present year was the greatest on record if stages of water alone are considered, although the actual volume of water was probably less than in the flood of 1897, the greater heights in 1903 being the result of the extension of the levee system. The rise of the Ohio and lower Mississippi Rivers was steady during February, owing to several heavy general rains, and during the last two days of the month another storm moved northeastward through the Ohio valley, making it certain that floods would occur. Other heavy rains occurred on March 7 and 8. The flood warnings of the Weather Bureau were timely and accurate. The stages which were forecasted, and those which were actually recorded, between Cairo and New Orleans are shown in the following table, taken from an article by H. C. Frankenfield on 'The Weather Bureau and the Recent Floods' (*Nat. Geogr. Mag.*, July, 1903).

Stations.	Forecast Stage (ft.).	Actual Stage (ft.).
Cairo	50.5 to 51	50.6
Memphis	40.0	40.1
Helena	51.0	51.0
Arkansas City	53.0	53.0
Greenville	49.0	49.1
Vicksburg	52.0	51.8
New Orleans	21.0	20.4 to 20.7

At Cairo the forecast was four days in advance, and at New Orleans twenty-eight days in advance of the crest.

At the end of May and early in June the floods on the lower Missouri and the upper Mississippi were greater than any on record except that of 1844. They resulted from heavy daily rainfalls over Kansas, coming in connection with persistent low pressures over the eastern slope of the Rocky Mountains. Similar conditions prevailed eastward into northwestern Missouri and Iowa. At St. Louis warnings were issued on June 5 of a stage of thirty-eight feet in about four days. That stage was exactly reached on the fifth day.

RAINFALL AND SUNSPOTS.

DR. W. J. S. LOCKYER continues his investigation of rainfall and sunspot cycles (*Nature*, Vol. 68, pp. 8–10). Smoothed rainfall curves for the British Isles, Brussels, Madras, Bombay, Cape Town and the Upper Ohio valley show a long-period variation at all the stations, and further, the occurrence of the greatest rainfall generally in the years 1815, 1845

and 1878–83, with the minima about the years 1825–30, 1860 and 1893–5. A continuation of the curves, based on the assumption that the apparent law already recognized holds good, indicates that the year 1913 will be at about the middle of the next wet epoch. The sunspot curve shows a close correspondence with the rainfall curves. There appears to be a long-period solar change of thirty-five years, the minimum of sunspots corresponding roughly with the maximum of rainfall. Dr. Lockyer concludes that 'since this long-period rainfall cycle synchronizes so well with the solar changes, the latter may render valuable assistance in determining the epochs of these dry and wet cycles.'

R. DeC. Ward.

Harvard University.

OPENING OF THE LAKE LABORATORY OF THE OHIO STATE UNIVERSITY.

On the afternoon of July 2, the new Lake Laboratory building of the Ohio State University, located on Cedar Point, Sandusky, Ohio, was formally opened. Several scientists from the various institutions of the State were present at the exercises, while many of those unable to be present responded with letters of congratulations and well-wishes. The director, Professor Herbert Osborn, opened the session by reading extracts from these letters, after which the first speaker of the day, Professor C. J. Herrick, of Denison University was introduced. Professor Herrick spoke on the Summer Laboratory as an instrument of scientific research. He took the stand that such institutions fulfil their functions not merely by giving investigators facilities and materials for research, but particularly in the culture of the investigators themselves. Exchange of ideas and consequent broadening of view is an important point in the consideration of the value of summer laboratories. The speaker expressed a hope that the several scientific institutions of the state would cooperate with the State University in making the laboratory an institution of the highest usefulness and gave assurance that such would be the policy of the colleges and universities of Ohio.

Hon. J. T. Mack, of Sandusky, a member of the Board of Trustees and representing that body, outlined the policy of the university with respect to the laboratory and emphasized the fact that it is a laboratory for the use of the scientific men of the state, regardless of their affiliations.

Captain Alexis Cope, secretary of the university, gave a detailed history of the laboratory as shown by the archives of the university. The idea of such an institution originated with the late Dr. Kellicott, in 1894. During the succeeding year, appropriations were made for an addition to the State Fish Commission building in Sandusky, the whole of which could be used during the summers as a lake laboratory. In 1899 the present director, Professor Osborn, made a request to the board for a more commodious building and recommended that it be erected on Cedar Point which is a tongue of sand twelve miles long and a few hundred feet wide at most. This was favorably received and the present building is the outcome.

Professor Denny, dean of the College of Arts of the University followed this speaker with the theme 'Comradeship in Science.' Men of science should associate with one another, as by so doing they become inspired to greater efforts and disappointments are belittled as they see how others meet and overcome difficulties. The dean said that the laboratory was a part of the university and that full credit would be given toward degrees for work done.

The director, Professor Osborn, concluded the program by thanking the friends of the institution and those that have acted as its promoters. The professor gave briefly a history of summer laboratories, tracing their origin to Penekese and Agassiz. He said that a new life is put in biological work by the founding of such institutions in that live material and natural environment is had in easy access. The director reiterated the desire expressed by another speaker that the laboratory would become, as its expressed purpose is, an open meeting ground for all biological workers of Ohio and adjacent states.

SCIENTIFIC NOTES AND NEWS.

THE University of London conferred honorary degrees for the first time on June 24, the degree of Doctor of Laws being given to the Prince of Wales, of Doctor of Music to the Princess of Wales and of Doctor of Science to Lord Kelvin and Lord Lister. The chancellor, Lord Rosebery, stated that the conferring of honorary degrees would not be an annual celebration, and that it was intended to make the degree of the University of London 'the most rare and the most precious in the annals of any university.'

DR. JOSEPH LARMOR, Lucasian professor of mathematics at Cambridge, received the degree of Doctor of Science from Dublin University on June 30.

PROFESSOR C. J. MARTIN, F.R.S., of the University of Melbourne, has been appointed director of the Jenner Institute of Preventive Medicine, London.

DR. LUTHER H. GULICK, director of physical training of the public schools of New York City, has been elected president of the National Physical Education Association.

DR. O. H. TITTMANN, superintendent of the United States Coast and Geodetic Survey, will sail for Europe on the steamship *Blücher* on July 23, to represent this government at the conference of the International Geodetic Association, which will meet this year in the Danish Parliament building at Copenhagen, on August 4. After the adjournment of the conference Dr. Tittmann will go to London and hold himself in readiness to assist the members of the Alaskan boundary tribunal, consisting of Secretary Root, Senator Lodge and ex-Senator Turner.

PROFESSOR F. W. PUTNAM is now on his way to California, where he is chairman of the committee on anthropology in the University at Berkeley. He has recently been made honorary member of the Royal Academy of Literature, History and Antiquities of Stockholm; corresponding member of the Berlin Anthropological Society; honorary member of the California Academy of Sciences and of the Missouri Historical Society.

H. G. TIMBERLAKE has been appointed a research assistant in botany in the Carnegie Institution for the coming year. He has been granted a year's leave of absence by the regents of the University of Wisconsin, where he was promoted to an assistant professorship in June.

LEROY ABRAMS, of the Stanford department of systematic botany, is doing field work in southern California for the New York Botanical Garden.

DR. F. W. CRAGIN, of the department of geology of Colorado College, has received from some public-spirited citizens of Colorado and other western states a grant of funds to enable him to conduct special researches in the early history of the Rocky Mountains and Great Plains; a subject in which, during the past five or six years, he has built up quite an extensive library. Intending to lay aside, for several years at least, the profession of teaching, he has resigned his chair in the college, and will give his chief energies to the historical work. He will devote a considerable part of the coming year to travel in the interest of these researches. He states that in appointing his successor, it is the desire of the trustees of Colorado College to secure, if possible, a man who combines a thorough knowledge of metallurgy with that of geology.

The Journal of the American Medical Association states that the friends and pupils of the recently deceased Professor E. Bottini had planned a 'Festschrift' in his honor with a gold medal and souvenir copy of his diploma on the occasion of his jubilee anniversary. The anniversary came soon after his death, and the University of Pavia was made the recipient of the honors in his name, the medal, diploma and 'Festschrift' to be duly preserved among the archives of the institution with the list of subscribers.

PROFESSOR S. W. WILLISTON, of the University of Chicago, president of the Sigma Xi Society, addressed the chapter of the society at the Ohio State University on June 22.

GOVERNOR LANHAM, of Texas, has issued a proclamation offering a reward of $50,000 from the state to any person who discovers

a practical method for eradicating the cotton boll weevil.

The Bufalini prize of the University of Florence will be awarded at the end of October of next year. This prize is of the value of $1,200 and is awarded once every twenty years. The subject is the value of the experimental method in opposition to the speculative or dogmatic method of scientific research.

The National Educational Association held a very large and successful meeting at Boston last week, there being a registration of some thirty thousand members.

The legislative council of Ceylon has invited the British Association for the Advancement of Science to meet in Colombo in 1907 or 1908.

The Swiss Society of Natural Sciences will hold its eighty-sixth session from the second to the fifth of September at Locarno. In connection with the society, which corresponds to the American and British Associations for the Advancement of Science, there are meetings of the Swiss societies of geology, botany, zoology and chemistry, and probably of the Zurich Physical Society. The society always provides a full program of entertainments and excursions, and the place of meeting this year is especially inviting to foreigners.

With the intention of fixing upon a proper forest policy, California has undertaken this year, with the help of the Bureau of Forestry, a comprehensive and detailed study of its forests. The state legislature recently appropriated $15,000 for the study, the condition being that it should be carried out by the Bureau of Forestry, and that the bureau should bear half the expense.

A cablegram from Berlin to the daily papers states that the official report of Professor Drygalski, of the German Antarctic expedition, was published on July 11. The report gives details of the movement of the expedition's vessel *Gauss* between January 31, 1902, and June 9, 1903, on which the *Gauss* reached Simonstown, South Africa. A number of newly discovered points were christened, one being Pesadowsky Bay, where the *Gauss* lay icebound during the winter. An ice free volcanic peak 1,200 feet high, which was discovered, was named the Gaussberg.

A telegram has been received, according to Reuter's Agency, from Major Powell Cotton, Northumberland Fusiliers, who left England about a year ago on an expedition across Africa from Mombasa, *viâ* Lake Rudolph and the Upper Nile. After leaving Mount Elgon, to the northeast of Victoria Nyanza, and remaining some time with the cave dwellers there, he marched due north, and since January has been traveling largely through unknown country. On May 11 he reached Obbo, some fifty miles to the northeast of Dufile. On January 1 the explorer left Mount Debasien, and proceeded through Karamojo to Tarash, in Western Turkana, in the Rudolph Province. In this region the tribes did not prove to be unfriendly, and, contrary to expectation, the notorious Turkana gave no trouble to the expedition. The country, however, was difficult and waterless. North of Tarash Major Powell Cotton crossed Captain Wellby's route and proceeded through Southern Dabossa and Dodinga to the Nile Province. During this portion of the route, part of which was unexplored, the natives were hostile. The explorer was in good health, and has secured some splendid trophies. He will probably be next heard of at Khartum.

English journals announce that an expedition is to start for New Guinea in August for the purpose partly of ethnological investigation, but also with the object of collecting data in regard to the distribution and etiology of cancer. The latter portion of the work has been officially recognized by the Cancer Commission. A grant has been made by the Royal Society towards the expenses of the expedition, and the Royal Geographical Society has undertaken to lend the greater part of the instruments for the geographical investigations which are to be carried out. The expedition, which has been organized in London by Major W. Cooke Daniels, will be unusually well equipped, and a schooner with auxiliary steam power will serve as a movable base. There

will also be a sea-going launch. Major Daniels, who has had much tropical experience, will devote himself mainly to ethnology and experimental psychology. Dr. C. G. Seligmann, until recently the superintendent of the clinical laboratory, St. Thomas's Hospital, is the representative of the Cancer Commission on the expedition, of which he is in general medical charge. With Dr. W. Mersh Strong, he will pay attention to pathological questions of a more general character. Dr. Strong will be responsible for the geographical and geological observations. The photographic work, which will include the use of the latest form of cinematograph for recording native dances and ceremonies, will be undertaken by Mr. A. H. Dunning.

Reuter's agency is informed that Commander Irizar, the Argentine naval officer who will command the relief expedition which is being sent out by the Argentine government in search of Dr. Otto Nordenskjöld's south polar expedition, will leave for Buenos Ayres in a few weeks. The relief vessel—the *Uruguay*—is an Argentine gunboat sheathed with wood, and has been selected as being specially adapted for the work in hand. She will be strengthened so as to withstand ice pressure. The complete plans of the relief expedition are not yet fully known. The ship will be in charge of Argentine officers and crew, and will be provisioned for two years. It is not, however, probable that she will winter in the Antarctic. Commander Irizar is leaving for Norway in a few days to buy furs and other stores. He was formerly in command of the Argentine warship *Patria*, in which ship Sub-Lieutenant Soveral, the Argentine officer now with Dr. Nordenskjöld, was serving.

The London *Times* states that the Museum of Zoology, of Cambridge University, has recently received a collection of books and specimens, bequeathed by the late T. E. Buckley, B.A., of Trinity College. In 1873 Mr. Buckley was given a grant from the Worts Fund, as the result of which he visited South Africa, returning with a valuable series of mammalian skeletons, which are now in the museum. In later years he continued to take a special interest in the same part of the world, and he accumulated a considerable collection of books and memoirs relating to African exploration, and in particular of those concerned with zoology. These books have now been bequeathed to the museum, and they constitute a most valuable and interesting collection of some 440 volumes, besides various unbound pamphlets. The remainder of Mr. Buckley's bequest consists of a collection of nearly 400 birds and numerous birds' eggs. These have not yet been thoroughly examined, but they appear to be in admirable condition, and they form a valuable addition to the museum.

UNIVERSITY AND EDUCATIONAL NEWS.

Illinois College, Jacksonville, receives nearly the entire estate, valued at $75,000, of the late Dr. Hiram K. Jones.

The late Mrs. Harriet Lane Johnston, of Washington, has bequeathed $60,000 to the Johns Hopkins University for the establishment of three scholarships. She has also bequeathed $300,000 for the establishment of an episcopal school at Washington for the maintenance, education and training of choir boys.

Mrs. Jane L. Stanford, having now delegated to the board of trustees of Leland Stanford Junior University the powers she formerly retained, has been elected president of the board.

The department of physics and electrical engineering at Lehigh University has been reorganized with Professor Wm. S. Franklin in charge of physics and Professor Wm. Esty in charge of electrical engineering. Professor Franklin is a graduate of the University of Kansas. He has pursued graduate study in physics at the University of Kansas, at the University of Berlin, at Harvard University and at Cornell University. He was five years in charge of physics and electrical engineering at Iowa State College and he has been for six years in charge of physics and electrical engineering at Lehigh University. Professor Esty is a graduate of Amherst College and of the Massachusetts Institute of Technology.

He was for one year with the General Electric Company at Lynn, Mass., eight years at the University of Illinois as instructor and as assistant professor of electrical engineering, and he has been for two years assistant professor of electrical engineering at Lehigh University.

The University of St. Louis, which recently purchased the Marion-Sims-Beaumont College of Medicine, has appointed Dr. Albert C. Eycleshymer, assistant professor of anatomy in the University of Chicago, as director of its Anatomical Department.

Benjamin S. Marigold, A.B. (Harvard, '76), Ph.D. (1901), instructor in industrial chemistry at the Worcester Polytechnic Institute for the past three years, has been appointed assistant professor of chemistry in Clark College. In the same institution Mr. James P. Porter, A.M. (Indiana), for the past two years instructor in Indiana University, has been appointed instructor in psychology.

Dr. Henry Albert has been elected assistant professor of pathology and bacteriology in the College of Medicine in the University of Iowa.

Professor Hettner succeeded Professor Kammerer as rector of the Technological Institute at Charlottenburg on June 30. The number of students in the institute last winter was 4,460.

Mr. Alexander Darroch, M.A., has been appointed professor of education in the University of Edinburgh, in succession to Professor S. S. Laurie.

Mr. John McCrae, Ph.D., senior lecturer in chemistry at the East London Technical College, has been appointed lecturer in chemistry at Queen Margaret College, Glasgow University.

Mr. T. Loveday, assistant lecturer in English and philosophy at University College, Bangor, has been appointed professor of philosophy at University College, Cape Town.

The London *Times* states that a number of appointments have been made in the department of education at Owens College, Manchester, in addition to that of Mr. J. J. Findlay, Wadham College, Oxford, to the Sarah Fielden chair of education in succession to the late Professor Withers as already announced. A special professorship of the history and administration of education has been established by the council. This chair has been offered to and accepted by Mr. Michael E. Sadler, M.A., formerly a student of Christ Church, Oxford, and late director of special inquiries and reports under the Board of Education. Mr. Sadler will reside in Manchester for one term in each academic year, and during his residence will take an active part in the work of the department. Miss C. I. Dodd, mistress of method, has been appointed an additional lecturer in education. Mr. H. T. Mark, B.A. (London), B.Sc. (Victoria), has been appointed lecturer on school hygiene. Miss S. A. Burstall, B.A. (London), Girton College, Cambridge, headmistress of the Manchester High School for Girls, and Mr. J. L. Paton, M.A., late fellow of St. John's College, Cambridge, head master of the Manchester Grammar School, have accepted the posts of special lecturers in education, and will give occasional lectures on special subjects. A revised prospectus will be issued shortly containing a statement of the courses proposed to be offered during next session for students training to be primary or secondary teachers, as well as for acting teachers already engaged in teaching in primary and secondary schools. The following public lectures (free) have already been arranged: Monday, October 12, at 8 p.m., inaugural lecture by Professor Findlay on 'Training for the Teaching Profession.' A series of four lectures by Professor Sadler —(1) 'The Educational Problem in England'; (2) 'The Task of the Local Education Authorities' (Wharburton lecture); (3) 'The Universities and National Education'; (4) 'The Need for Scientific Investigation in Education.'

Dr. H. Spencer Harrison has been appointed demonstrator and assistant lecturer in biology at University College, Cardiff.

Dr. T. Slater Price succeeds Mr. Woodward as director of chemical studies at Birmingham Municipal Technical School.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JULY 24, 1903.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE TWENTY-EIGHTH GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY.

THE twenty-eighth general meeting of the American Chemical Society was held in Cleveland on June 29 and 30. At the opening session, held in the rooms of the Associated Technical Clubs, Professor Edward W. Morley gave a brief address of welcome in behalf of the Cleveland Chemical Society.

In his reply the president, Professor John H. Long, paid a well-merited tribute to the work of two Cleveland men, Professors Morley and Mabery.

In the afternoon following the first session the members of the society were taken on a most entertaining drive through one of Cleveland's chief industrial centers, where the iron furnaces, the works of the Grasselli Chemical Company and the Standard Oil Company, the ship yards and many minor concerns could be seen to good advantage.

In the evening, the visitors were again the guests of the local society at an informal smoker at the rooms of the University Club. By invitation of the officers of the society, Dr. Gomberg presented a discussion of the subject of trivalent carbon. In a very lucid and interesting talk, he outlined the way in which he was led to the discovery of triphenylmethyl, and the series of proofs by which its structure

may be considered established. He also announced that analogous substances (as, for example, the tritolyl compound) have recently been prepared, showing that triphenylmethyl is only one example of a class. The only hypothesis so far that explains the facts is that carbon is trivalent in these compounds. Specimens and some simple experiments added to the interest of the talk. The speaker was warmly applauded.

After the Tuesday morning session, held in the chemical laboratory of Case School, the Grasselli Chemical Company generously treated the members of the society to a drive through some of Cleveland's beautiful parks, followed by a luncheon at the Hollenden Hotel.

A subscription dinner in the evening was attended by forty-five. The toastmaster, President Long, to use his own phrase, 'swung round the circle,' and called on representatives from the various sections.

There were several excursions to manufacturing establishments of interest to chemists. All in all, the meeting was one of the most enjoyable the society has held, and the vote of thanks to Professor Hippolyte Gruener, to the Cleveland Chemical Society and to other local men who contributed to the enjoyment of the visiting members was hearty and unanimous.

The total attendance was 107, 70 of whom were from places outside of Cleveland.

The next meeting will be held in St. Louis during the first week of January, 1904, in affiliation with the American Association for the Advancement of Science.

Following is a list of the papers presented:

Contributions to the Chemistry of Hydronitric Acid: L. M. Dennis and A. W. Browne.

The acid is best prepared by causing ammonia gas to bubble through molten sodium kept at 350°, and treating the resulting sodium amide with nitrous oxide at a temperature of about 90°. In the second reaction a 90 per cent. yield of the sodium salt, NaN_3, is obtained. Ferric chloride is a good reagent for qualitative tests.

The Transport Number of Sulphuric Acid: O. F. Tower.

An apparatus was described having a platinum cathode and a cadmium anode. At a dilution of one fifth normal the transport number changes only very slightly with increasing dilution, indicating that at the point named practically all the HSO_4 ions have been broken up into $\overset{+}{H}$ and $\overset{=}{SO_4}$.

Electrolytic Conduction with Reference to the Ion Theory: Nevil Monroe Hopkins. (By title.)

The Rôle of Water in the Electro-deposition of Lithium from Pyridine and from Acetone: H. E. Patten and W. R. Mott.

Lithium may be deposited, from pyridine and acetone solutions of its chloride, on platinum, iron, aluminum and copper. The deposition is interfered with by the presence of water; in the case of pyridine very seriously so, owing to the formation of a high-resistance film.

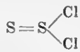
The Viscosity of Solutions of Metallic Salts: Its Bearing upon the Nature of the Compound between Solvent and Solute: Arthur A. Blanchard and Morris A. Stewart.

Change of viscosity with change of concentration is believed to follow a linear formula in cases where no definite hydrates are formed. The formation of a compound with ammonia decreases the viscosity of a metallic salt solution, while pyridine has the opposite effect.

The Vapor Tension of Ammoniacal Copper Sulphate Solutions: JAMES LOCKE. (By title.)

The Constitution of Sulphur Chloride: W. R. SMITH and I. F. B. WADE.

Two facts which speak for the asymmetrical formula



are the synthesis from thionyl chloride and the formation, when sulphur chloride reacts with such substances as zinc ethyl, of compounds containing only one atom of sulphur.

Mercurous Sulphide: CHARLES BASKERVILLE. (By title.)

Attempts to prepare Certain Rare Earth Alums, and on Some New Double Sulphates: CHARLES BASKERVILLE and HAZEL HOLLAND. (By title.)

On the Purification of Neodidymium: CHARLES BASKERVILLE and RESTON STEVENSON. (By title.)

Præseodidymium Tetroxide: CHARLES BASKERVILLE and J. B. THORPE. (By title.)

New Peroxides of Certain Rare Earths: CHARLES BASKERVILLE and T. B. FAUST. (By title.)

Mordanting with the Rare Earths: CHARLES BASKERVILLE and T. B. FAUST. (By title.)

Some New Organic Salts of Zirconium: CHARLES BASKERVILLE and H. H. BENNETT. (By title.)

The Proportions of Silver Nitrate and of Silver Sulphate Formed by the Action of Nitric Acid on Silver Sulphide: HIPPOLYTE GRUENER.

When a large amount of strong acid is used, the product is almost entirely sulphate; the maximum amount of nitrate was obtained by long boiling with 4 per cent. acid; even here 10 per cent. of the product is sulphate.

The Action of Dissolved Oxygen on Cuprous Chloride: W. M. BLANCHARD and BERT D. INGLES.

As previously shown by Vogel, water containing air acts on cuprous chloride according to the equation

$$2Cu_2Cl_2 + O = Cu_2O + 2CuCl_2,$$

but not more than 97 per cent. of the amount present can be so converted. If, however, gaseous oxygen is passed into water containing cuprous chloride in suspension, a bluish basic chloride results.

The Action of Hydrogen Peroxide on Cuprous Chloride: W. M. BLANCHARD.

A chocolate-colored basic chloride is first formed which soon changes to a greenish blue basic chloride supposed to be

$$CuO.CuCl_2.4H_2O.$$

Oxygen is simultaneously evolved.

On the Changeable Hydrolytic Equilibrium of Dissolved Chromic Sulphate: T. W. RICHARD and F. BONNET, JR.

The authors confirm the conclusion of Whitney and Recoura that a green basic substance exists in the green solution, but they show further that the substance is much more basic than was previously supposed. The investigation will be continued.

On the Deposition of Sodium from a Solution of Sodium Iodide in Acetone: H. E. PATTEN and W. R. MOTT. (By title.)

On the Deposition of Zinc Chloride Dissolved in Acetone: H. E. PATTEN. (By title.)

Derivations of Trichlorethylidene-dinitrophenamine: ALVIN S. WHEELER and M. R. GLENN. (By title.)

Some Salts of Triphenylmethyl: M. GOMBERG and L. H. CONE. (By title.)

Triphenylmethylacetate: M. GOMBERG and J. T. DAVIS. (By title.)

2-Amino-3,5-bibrombenzoic Acid, its Nitrile, and Synthesis of Quinazolines from the Latter: Marston T. Bogert and William F. Hand.

Both anthranilic acid and its nitrile can be brominated directly by the nascent bromine obtained by the interaction of potassium bromide, potassium bromate and hydrochloric acid. Anthranilic acid gives, in this way, 2-amino-3,5-bibrombenzoic acid. The nitrile gives the corresponding bibrom compound.

The Acids of the Colophonium of the Northern Pine: G. B. Frankforter and Clara Hillesheim.

The colophonium of the northern pine, instead of being, as Luce thinks, a single compound corresponding to the acid $C_{20}H_{30}O_2$ (abietic acid), is found to contain two acids, $C_{25}H_{38}O_5$ and $C_{38}H_{55}O_4$, which can be separated in the form of the ammonium salts by passing dry ammonia into a dry ethereal solution.

The Products of the Pitch of the Douglass Fir: G. B. Frankforter.

The butt of this tree is unusually rich in pitch, containing as high as 41.6 per cent. Of the pitch, 21 per cent. is turpentine. The latter has about the same boiling-point as that from the northern pine (150°) but differs from it in other properties. The turpentine and other products (pyroligneous acid, charcoal, etc.) from one such butt discarded by the lumbermen would have a value of $275.

This paper elicited much interesting discussion, especially with reference to the decrease in the production of turpentine in the south.

The Derivatives of Eugenol: G. B. Frankforter and Max Lands.

Eugenol forms a di-, tri- and tetrabromide, in each of which all but one bromine atom enter the ring. In the case of chlorine derivatives all but *two* atoms enter the ring. A pentachloride was obtained, but not a pentabromide.

The Synthesis of β-Methyladipic Acid: W. A. Noyes and I. J. Cox.

This is the first synthesis of this compound from simple materials; by starting with levulinic acid, passing to the valerolactone, thence to γ-bromvaleric ester and synthesizing with cyan-acetic ester. α-β-dimethyladipic acid was also obtained.

Kansas Petroleum: Edward Bartow.

The field is comparatively new. Nineteen specimens collected from various parts of the state show the unusual variation of from 0.84 to 0.94 S. G., and a very low sulphur content. The bromine absorption is greatest for the heavy oils.

The Determination of Sulphur in Iron: Allen P. Ford and Ogden G. Willey.

A review of the methods in common use. Evolution methods usually give results entirely too low; oxidation methods give good results when worked by men who understand them. Bamber's method is recommended as being generally applicable, and deserving of more attention than it has received.

The Toxic Limits of Acid for Some Seedlings: Frank K. Cameron.

The results of these experiments show clearly that, owing to variations caused by the effects of light, temperature and the individual characters of plants, methods of this nature do not furnish safe conclusions in physical-chemical investigations.

On the Chemistry of the Colon Bacillus: Mary F. Leach. (By title.)

Nitrification in Arable Soils: W. A. Withers and G. S. Fraps. (By title.)

Analysis of Sea Water from Woods Hole, Mass.: A. P. Saunders.

Analysis of a small sample showed a total of solid constituents much lower than that usually given for Atlantic water.

In the discussion one of the members stated that another sample, drawn from the same locality but at a different time, was found by him to be of normal composition.

On the Relation of the Specific Gravity of Urine to the Solids Present: J. H. LONG. (By title.)

Cereal Foods: EDWARD GUDEMAN.

Analysis of a large number of samples from forty-three different manufacturers shows an average composition of

Ash	0.3
Fiber	0.5
Fat	0.7
Proteids	10.5
Carbohydrates (by difference)	88.0
	100.0

The Determination of Starch: W. A. NOYES and R. B. ARNOLD.

One of the objects of this work was to determine the best conditions for hydrolysis. One hour is the most favorable length of time with 0.5 per cent. acid at a temperature of 100°, or half an hour at 111°. Solutions giving 2 per cent. glucose give better results than those giving 0.5 per cent. glucose. In neutralizing the acid, it is much more desirable to stop a little short of the exact point rather than to overstep it. The greatest hydrolysis that could be obtained was 96–99 per cent. of the theoretical.

AUSTIN M. PATTERSON.

THE CASE FOR VACCINATION.

THE recent appearance of an admirable book entitled 'A Concise History of Smallpox and Vaccination in Europe,' by Edward J. Edwardes, has aroused new enthusiasm among British sanitarians in their efforts to undo the evil effects of the last Vaccination Act, which permitted the exemption of those persons known as 'conscientious objectors.' Its lesson is equally salutary in this country, where the vaccination laws are at present far too lax, and where the opponents of vaccination are conducting an active campaign for their repeal.

It should be frankly acknowledged that the responsibility incurred by the state in compelling its citizens to submit to the introduction of vaccine matter is a grave one. It is, in the first place, a serious infringement of personal liberty; and, in the second place, it must be owned that the process is attended with a certain, though an almost inappreciable, amount of danger. When arm-to-arm vaccination was practised, loathsome diseases were occasionally conveyed from one human being to another, but the general introduction of calf lymph now prevents the possibility of any such contingency. The transmission of tuberculosis, too, is effectually precluded by the tests to which the calves are submitted and by the addition to the lymph of glycerin. Erysipelas and tetanus, on the other hand, still sometimes follow vaccination. In a very large majority of cases these complications are due to secondary infection by the removal of dressings from the vaccination wound; in a few instances they have been traced to infection of the lymph itself. The extent of these dangers is, however, very slight. Dr. McFarland* in a careful review of all previous medical literature, was last year only able to find 95 cases of tetanus recorded as due to vaccination. The total number of deaths from erysipelas in the United States in 1900 was 2,861, and the total number from tetanus, 1,664, in a population of 75,994,575 with 1,039,094 deaths from all causes; and it can scarcely be claimed that any large proportion of this insignificant number was due to vaccination.

On the other hand, the benefits which

* 'Tetanus and Vaccination,' *Journal of Medical Research*, VII, 1902, p. 474.

vaccination has bestowed upon the human race may best be estimated by comparing the popular dread of smallpox prior to 1800 with the indifference with which it is regarded now. The 'Concise History,' referred to above, begins with a series of citations from the earliest medical writers, and we note that Rhazes, in the tenth century, attempted to explain how it happened that scarcely any one could escape the disease, and Mercurialis (born in 1530) said that 'almost every person must have it once.' In the eighteenth century statistics first became available from the works of Süssmilch, De la Condamine and others. The most important are those of Sweden, where in the period from 1774 to 1800 the annual smallpox death rate averaged 2,049 per million living and accounted for about one thirteenth of the total deaths from all causes. The statistics for Copenhagen, for London, for Berlin, for Liverpool and for Glasgow show in general the same relations, although in the latter city from 1783 to 1800 smallpox caused nearly one fifth of the total deaths. Nine tenths of the fatal cases of smallpox occurred in children under ten years of age.

Towards the end of the eighteenth century the struggle against this dread disease seemed almost hopeless. The practise of inoculation, which consisted in the introduction of actual smallpox matter under the skin, in order to induce a mild attack at a time when the body was in condition to meet it, had failed to effect any reduction in the general death rate. Just when it seemed that 'the continued raging of that pitiless plague' was the only prospect for mankind, Edward Jenner proved that an attack of the mild disease of cattle known as cowpox furnished protection against infection with the smallpox. He suggested 'vaccination' with cowpox material as a simple prophylactic against smallpox, and it is the introduction of this process which Dr. Edwardes calls 'the greatest sanitary fact which the world has ever known.' It was in June, 1798, that the physician of Gloucestershire published his 'Inquiry into the Causes and Effects of the Variolæ Vaccinæ,' and by 1801 it had been translated into Latin, German, French and Dutch. "As if an angel's trumpet had sounded over the earth, thus spread the good tidings into all lands, that a preventive had been found against the horrible disease smallpox, so long the scourge of humanity."

The protective effect of vaccination was at once established by actual experiment, and on a very large scale, by inoculating those who had been vaccinated with the true smallpox virus. Woodville stated in 1802 that of 7,500 persons vaccinated at the smallpox hospital, about one half had been since inoculated, without any effect being produced. Dr. Charles Creighton and Alfred Russel Wallace, the chief authorities of the 'anti-vaccinationists,' have attempted to discredit these tests by claiming that Woodville's lymph was contaminated and that the vaccination was really inoculation in itself. It is amusing to note that Wallace adopts this explanation on page 8 of his 'Vaccination a Delusion,' and on page 76 of the same book seriously maintains not only that vaccination exercises no protective effect, but that after a previous attack of smallpox 'instead of there being any immunity, there is really a somewhat increased susceptibility to a second attack.' It is odd that this startling fact was not noticed in the days when every one had the smallpox at least once! Woodville's account of his experiments shows that only a very small proportion of his cases—and those all prior to June, 1799—lay open to the objection mentioned above, and his conclusions were confirmed by similar tests, notably by 8,000 cases treated at the Medical College in Berlin. A small but

well-controlled experiment was carried out at Milton, Massachusetts, in 1809, with the same result.

The statistics of the early part of the nineteenth century furnish the first evidence of the effect of vaccination as applied upon a large scale. In Sweden, for example, the average annual smallpox rate per million was 1,914 from 1792 to 1801, 623 from 1802 to 1811, and 133 from 1812 to 1821. In Berlin the actual deaths from the disease amounted to 4,453 for the ten years 1782–91, 4,999 for the next decade, 2,955 for 1802–11, and 555 for 1812–22. The facts are brought out in a still more striking manner when the figures are plotted graphically, as was done for London from 1650 to 1900 by Dr. Newsholme.* Wallace published a similar diagram of the Swedish death rates which is alone enough to convince a candid student that something remarkably affected smallpox mortality about 1800; but he closed his eyes to its obvious teaching, and maintained that inasmuch as the curve fell off sharply from 1800 to 1803 before vaccination had become general, the decrease was due not to vaccination, but to 'sanitation.' It is certainly true that the deaths from smallpox decreased in the two or three years after 1800 without reference to vaccination, just as they had decreased periodically after every epidemic in the eighteenth century. But after every such previous decrease the mortality had risen again within five or ten years to another maximum. Why, after the decrease in 1803, did the death rate in Sweden remain at a minimum, never having risen since 1809 over 1,000 per million, and but four times over 500, while in 1801 it was 2,566, in 1800 5,126, in 1799 1,609, in 1796 1,963 and in 1795 2,956? There is not the smallest shred of evidence that 'sanitation' received any great and sudden impetus at exactly this time, unless sanitation be used to cover all the arts which tend toward 'the prevention of premature death.' In this wholly legitimate sense sanitation includes a number of prophylactic measures, each adapted to the diminution of a specific disease. When sanitation covered only isolation and quarantine it could control plague to a certain extent, but not smallpox, not typhoid fever, not diphtheria, not measles. When vaccination became a sanitary measure, sanitation conquered smallpox; but typhoid fever was not restricted until the day of water supplies and sewerage systems; diphtheria, not until the introduction of antitoxin. A fairly steady decrease in the general death rate has, indeed, occurred, due to a complex of factors not easily analyzed, but a sudden collapse such as that which affected the smallpox death rate after 1800 has never been manifest without a definite and tangible cause. That 'sanitation' has not affected the other zymotics to the same degree as smallpox has been graphically shown by A. F. Burridge in a recent publication.*

During the first quarter of the nineteenth century it was thought that a single vaccination in infancy would give indefinite protection against smallpox; but about 1830 this view began to lose ground. An adult population now existed, protected, not, as in other times, by previous attacks of smallpox, but only by the less potent effect of vaccination. Smallpox began, therefore, to recur, but modified in two notable respects. In the first place, its age incidence had shifted; whereas of 1,252 cases in three Prussian towns before vaccination began, 94.5 per cent. were under ten and not one over twenty years; of 1,677 cases in Wür-

* 'The Epidemiology of Smallpox in the Nineteenth Century,' *British Medical Journal*, July 5, 1902.

* 'Vaccination and the Act of 1898,' *Journal of the Institute of Actuaries*, October, 1902.

temberg after vaccination began, 18.4 per cent. only were under 10, and 42 per cent. over twenty years. So it is shown by Dr. Creighton in his article on 'Vaccination' in the 'Encyclopedia Britannica,' that, in England and Wales, about 1847, three fourths of the deaths occurred under five years, while in the eighties less than a quarter of the decedents were of this age. In the second place, beside this shifting of incidence, smallpox among the vaccinated proved much less fatal, even when it was contracted, than among the unvaccinated.

Although minor epidemics began to recur, smallpox in vaccinated countries was insignificant in amount until 1870–5, when a 'pandemic' swept over Europe which recalled the normal conditions of the pre-vaccination period. Considering the varying virulence of disease at different periods, and the fact that the importance of revaccination was not at all realized, such an epidemic was to be expected. The statistics for the early seventies have been used most dishonestly by the anti-vaccinationists in comparison with selected years of low mortality immediately after the introduction of vaccination in the attempt to show that no progress has been made. The worst year of this period in England and Sweden, however, showed a death rate about half the average yearly rate for the last quarter of the eighteenth century.

A comparison of the incidence of smallpox in this pandemic of 1870–5 upon different countries introduces the second class of evidence as to the value of vaccination. Thus Dr. Edwardes shows that for four countries having compulsory vaccination the average yearly smallpox death rate per million inhabitants was as follows: England, 361; Scotland, 314; Bavaria, 346; Sweden, 333. On the other hand, the rate for the same period was 953 in Prussia, 1,360 in Austria, 1,293 in Belgium and 958 in the Netherlands. All these countries had at this time no compulsory vaccination. The reverse has been affirmed in the case of Prussia, and Creighton, in the 'Encyclopedia Britannica,' states that revaccination 'has been more or less the law in Prussia since 1835,' and that 'Prussia was the best revaccinated country in Europe' in 1871. Dr. Edwardes discusses this question in some detail and quotes the official documents, which show explicitly that there existed in Prussia 'kein gesetzlicher Zwang zur Impfung.' Furthermore, the actual ratio of vaccination to births in Berlin is on record, and the percentage ranged from 29 to 58 between 1865 and 1870. In this city there were 6,326 smallpox deaths per million living in 1871!

The 'great pandemic' taught the lesson that both vaccination and revaccination were essential. In 1874 Germany enacted a law providing for compulsory vaccination within the second year and revaccination within the twelfth year. In Prussia the death rate, which had ranged from 95 to 2,624 per million from 1866 to 1874, dropped to 36 in 1875 and has been under 10 since 1885. For the empire as a whole, statistics, available only since 1886, show a rate of 4.2 in that year, decreasing to .5 in 1895 since which there has been annually less than one death per million. A comparison with the statistics of Austria graphically made by Dr. Edwardes furnishes as striking a proof that vaccination is the only kind of sanitation which affects smallpox as could well be desired. Before 1870 the two countries had about the same amount of smallpox; since 1875 that in Austria has increased and that in Prussia has practically disappeared. The only difference in conditions lies in the law of 1874.

Army statistics furnish striking confirmatory evidence. Thus Burridge* compares

* *Loc. cit.*

the Prussian army, in which revaccination on entrance has been compulsory since 1834, with the French army, where it has only been thoroughly carried out since 1888, and with the Austrian army, where there was no revaccination prior to 1886. The attack rate per 100,000 in 1875–85 was 4.7 in the Prussian army, 133.6 in the French army and 333.7 in the Austrian army. In the twenty-five years 1875–99 there were only two deaths from smallpox in the Prussian army, one in 1884 and one in 1898. The main point to notice is that these extraordinary results have been attained by a general revaccination of the whole population. Revaccination of only a single class in the community can not prevent the occurrence of occasional cases in that class, because in a large body of men there must always be some vaccinations which have not been successful. Thus the smallpox death rate in the English army with revaccination has ranged from zero to twenty-nine during the last forty years. Wallace in 'Vaccination a Delusion' made these figures look larger by raising them to rates per million (the basis of calculation being about 200,000 men), and then compared them with the rates for Ireland at the age period 15 to 45, which were only slightly higher from 1864 to 1894 (58 for the army, 65.8 for Ireland). Later he showed that the rate for 1873–94 was 37 in the army, 36.8 in the navy and 14.4 in the city of Leicester, and concluded that 'all the statements by which the public has been gulled for so many years as to the almost complete immunity of the revaccinated army and navy are absolutely false.' 'There is *no* immunity. They have *no* protection.' That is, Mr. Wallace selects one island in Europe where, largely from its isolation, smallpox happens not to have been serious, and one town in England where there has been almost no smallpox, and because these two places have had extraordinarily low death rates he maintains that the low army death rate, indicates no protection! Yet the figures were before him which showed that the average of the annual death rates in the navy, which was less than 32 from 1873 to 1899, had been 257 from 1860 to 1873; in 1873 an order was issued which provided for the vaccination of all recruits on joining.

The evidence derived from a comparison of the same country before and after the introduction of vaccination, and that based on the contrast at the same period between countries having different degrees of vaccination, have now been briefly considered. The third class of facts includes the 'direct evidence' of the incidence of smallpox upon persons in the same community protected and unprotected by vaccination. At Chemnitz in 1870–1, a special census was made to determine the condition of the population as regards vaccination, and it appeared that among those protected by vaccination or previous smallpox the death rate was 1.2 per 10,000, while in the unprotected it was 442.9. Similarly at Sheffield in 1887–8* the deaths per 10,000 were 7.5 among the vaccinated and 347.9 among the unvaccinated. An objection to statistics of this sort, made with some plausibility, is that the unvaccinated class includes a large proportion of children and of persons in feeble health or living under poor sanitary conditions. Regarding the first point, the Sheffield figures are conclusive. They are divided according to age periods and show that the rates per 10,000 living between fifteen and twenty years were, 7.0 in the vaccinated and 1,355.5 in the unvaccinated. Here no age difference comes in question. The second contention is met by the statistics collected by Körösi with reference to 14,678 persons dying from various causes in some Hungarian hospitals in 1886. The unvaccinated constituted 14

* Reviewed by Burridge, *loc. cit.*

per cent. of those who died from other diseases than smallpox and 81 per cent. of those who died from smallpox. Obviously it was the lack of vaccination which was at fault here, not feeble health nor unsanitary conditions. In opposition to these figures the anti-vaccinationists quote the experience of the city of Leicester, where since 1882 the number of vaccinations has steadily decreased, falling to less than two per cent. of the births in some recent years. Smallpox has been introduced a number of times (38 cases in 1892, 308 in 1893, 8 in 1894, 4 in 1895, 4 in 1901), but has not spread extensively, and the death rate has remained very low. The opponents of vaccination also quote, by way of contrast, statistics showing that an increasingly large proportion of hospital cases of smallpox occur among the vaccinated,* and that in epidemics the attack of an unvaccinated person is often not recorded for some time.† Facts of the last two classes have, of course, no special significance except to indicate the need for revaccination. No one now supposes that a single vaccination affords absolute permanent protection, and with the increase of vaccination there must naturally come an increase of cases among the vaccinated. The experience of Leicester, on the other hand, is certainly of interest. It shows that under certain conditions the dangers of neglected vaccination may for a time be braved with impunity by a considerable portion of the community. This has been so far accomplished by prompt reporting and strict isolation of cases, and, according to the chairman of the public health committee of the town by the fact that 'a handful of the population, including the medical men, sanitary staff, smallpox nurses, etc., are as well vaccinated in Leicester as in any other town, so that a cordon of protected persons can at once be drawn around any case of smallpox which may occur.'* It should be remembered, however, that the population of Leicester is still to some extent protected by the vaccinations carried out prior to the anti-vaccinationist agitation. Thus of the 358 persons attacked in 1892–5, 198 were returned as having been at some time vaccinated. The experience of Gloucester is ominous for the future of the 'Leicester experiment.' Prior to 1892–3, according to Dr. Edwardes, 'vaccination had been almost in abeyance, in Gloucester, and the inhabitants lived in a fools' paradise.' The result was an epidemic of 1,979 cases, with 434 deaths in a population of about 40,000, giving a death rate of 10,000 per million!

With regard to the smallpox occurring in persons once vaccinated, there are two points to notice. In the first place, the ratio of deaths to cases is far lower than among the unvaccinated. Thus at the Leipsic city hospital in 1870–2 99 died among 139 unvaccinated cases, 116 died among 1,504 vaccinated cases, and none among 13 revaccinated cases. Creighton and Wallace object to these statistics on the ground that the death rate thus apparent among the unvaccinated is obviously too high, because 'in pre-vaccination times the death rate (18.8 per cent.) was almost the same as it is now in the vaccinated and unvaccinated together' (Creighton. Now it is quite impossible to fix any such general fatality rate; the ratio of deaths to cases has varied within wide limits both in the eighteenth century and recently. In the second place, it has been claimed that the 'unvaccinated' death rate is swollen by the inclusion in that class, of children who escaped vaccination on account of feeble

* London smallpox hospital, 40 per cent. in 1838, $94^6/_{10}$ per cent. in 1879—Wallace.

† The first unvaccinated case was the 174th at Cologne in 1870, the 42d at Bonn in the same year, and the 225th at Liegnitz in 1871—Creighton.

* Windley, 'Leicester and Smallpox,' *Journal of State Medicine*, January, 1903, p. 21.

health. In the case of Gloucester, where vaccination has been so generally neglected, this objection can hardly apply. Yet at Gloucester in 1892–3, there were, under ten years of age, 26 attacks among the vaccinated with one death, and 680 attacks among the unvaccinated with 279 deaths. Statistics for six towns collected by the English Royal Commission of 1889 showed fatality rates of 35.4 among the unvaccinated and 5.2 among the vaccinated. The third objection made to the hospital statistics, namely, that the deaths of the unvaccinated class are unfairly increased by the inclusion of doubtful cases and those who have been vaccinated but show no scars, can scarcely apply to the commission's analyses. It will not, at any rate, have much weight, except with those who, like Mr. Wallace, believe that "in this matter of official and compulsory vaccination both doctors and government officials, however highly placed, however eminent, however honorable, are yet utterly untrustworthy."

A second important characteristic of the cases of smallpox in a once vaccinated population is that they are not only comparatively light, but that they affect the later periods of life; and this represents an important gain in the life capital of the community. During the epidemic of 1870–3, Bavaria, with compulsory vaccination, had 851 deaths under, and 3,520 deaths over, twenty years, while the Netherlands without compulsory vaccination had 14,048 deaths under twenty and 6,524 at higher ages. In the same great epidemic 71 per cent. of the deaths at Leicester and 64 per cent. of the death at Gloucester occurred under ten years. In London the percentage falling in this age class was 37, and in Warrington, with still more thorough vaccination, it was 22.5.

A single vaccination then greatly reduces the probability of an attack of smallpox, postpones it to a later period of life and renders it less dangerous if it does ensue. To ensure absolute protection revaccination is required; and its efficacy is well indicated by the experience of the Prussian army. In addition, one single bit of evidence may be adduced which is more striking, perhaps, than all the rest, the statistics of nurses in smallpox hospitals. These figures are of special interest because we have here a fairly large class of persons whose condition as to vaccination is accurately known, and who are uniformly exposed to the contagion of the disease; and the experience of two such communities is quoted by Dr. Edwardes. "During the epidemic of 1871 there were 110 persons engaged in the Homerton Fever Hospital, in attendance on the smallpox sick; all these, with two exceptions, were revaccinated, and all but these two escaped smallpox." "Of 734 nurses and attendants in the Metropolitan Asylums Board Hospitals, 79 were survivors from smallpox attack—they escaped infection; 645 were revaccinated on entrance—they all escaped; 10 were not revaccinated, and the whole 10 took smallpox."

If statistics ever proved anything those quoted above prove the protective influence of vaccination. If any fact in science is certain, it is certain that a successful vaccination absolutely prevents smallpox for a period of some seven to ten years, that after that period it renders the disease less fatal, and that its complete protective effect may be renewed by revaccination. The conclusion is obvious, not only that the state should oblige primary vaccination, but, in the words of a minority of the British Royal Commission, that 'a second vaccination, at the age of twelve, ought to be made compulsory.'

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ON USES OF A DRAWING BOARD AND SCALES IN TRIGONOMETRY AND NAVIGATION.*

It may seem a little strange that any one should think it worth while to call special attention to a drawing board and scales as a means of solving spherical triangles and a few somewhat similar problems. For, accurate results can be obtained through simple computations and rough results by aid of suitable diagrams composed chiefly of curve systems. Such, for instance, are many cartographic projections of the great and small circles of a hemisphere. But where results reliable to about 5′ of arc or angle are required, and where computation is to be altogether dispensed with, it seems to me that the methods about to be described certainly possess merits which have not heretofore been fully recognized.

Suppose the dimensions of the drawing board to be about 22 by 40 inches. Let it be trimmed, as it were, with a metallic border three margins of which are divided into degrees and fractions of degrees so as to form a large rectangular protractor, as sketched in Fig. 1. The border of the fourth side may be graduated uniformly from its center, where is situated a pivot or pin about which the scales may revolve.

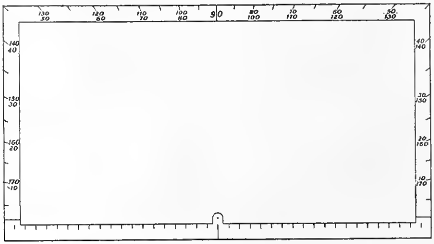

Fig. 1.

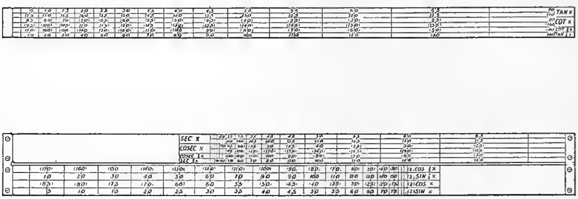

Fig. 2.

The scales to be used in the solution of spherical triangles are scales of sines, cosines, tangents, etc., like those shown in Fig. 2, but having, of course, much finer graduations along the edges. For use upon a 20-by-40-inch board, the extreme length of the scales should be about 30 inches. For increasing the size of the divisions, we shall suppose sines and cosines to have been multiplied by 2 in constructing the scales. In addition to trigonometrical scales it is supposed that we have several

* Delivered before the Philosophical Society of Washington, January 31, 1903.

uniformly graduated scales, which are especially useful in problems involving plane trigonometry, and a set of scales of meridional parts for various latitudes, each scale representing, say, 10 degrees of latitude. In all cases the scales must be straight and beveled on their edges. It is supposed that we have also a T-square with a uniformly graduated blade.

RIGHT SPHERICAL TRIANGLES.

By means of the board and scales we can find such products as cot $b \times$ tan c by laying off cot b, according to the scale labeled cot x, along the base line of the protractor. Let a straight edge, turning about the

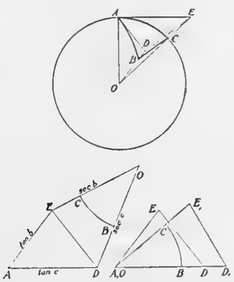

FIG. 3.

pivot, be directed toward value c on the margin. The T-square shows the line extending from the point where cot b was laid off to the straight edge. The distance is the product cot $b \times$ tan c. By reading this distance on a scale cos x, or double this distance on a scale 2 cos x we obtain a certain angle which is the value of the angle A of a triangle right-angled at B. Napier's rules enable one to see at a glance what product is required and how it is to be read. Where tangents and cotangents are involved, the application of this method is, of course, somewhat restricted on account of the length of the scales.

SINE RATIOS IN SPHERICAL TRIANGLES.

If two of the three given parts of a triangle are opposites, the unknown part opposite the third given part becomes known through the equality of the sine ratios; viz.,

$$\sin A : \sin a = \sin B : \sin b = \sin C : \sin c,$$

or

$$\sin A \sin b = \sin B \sin a, \text{ etc.}$$

The process of mechanically solving such problems can be illustrated by taking a particular case or problem; given A, a, B to find b.

Find a on the scale labeled 2 sin x and direct the scale (pivoted to the board) towards B as found on the margin of the

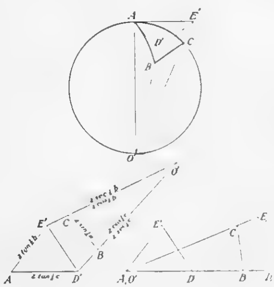

FIG. 4.

board; this locates a certain point. Next direct the scale towards A. Find on the scale as now directed a second point whose altitude is the same as that of the first. This is done by sliding the graduated T-square. The reading of the second point on the scale labeled 2 sin x (still pivoted to the board) is the required side b.

RELATION BETWEEN THE THREE SIDES AND ONE ANGLE.

In treating the problem—given the three sides to find an angle, or given two sides and the included angle to find the remaining side—it is important to consider two

methods, or constructions, analogous, but differing somewhat from each other. The first may be referred to as the gnomonic method, and the second as the sterographic.

Let ABC, Fig. 3, be the spherical triangle. A plane tangent to the sphere at A contains the lines AD, AE, whose lengths are tan c, tan b. Imagine the triangle ODE revolved about DE into the plane ADE. In the plane quadrilateral $ADOEA$ thus obtained, $OD = \sec c$, $OE = \sec b$, $OB = OC = 1$; also arc $BC = a$, which measures the angle O.

Assume now that we have scales of tangents and secants. The quadrilateral constructed by aid of such scales and a protractor gives the angle A when a, b, c are the known parts, or a when A, b, c are known. In practice the quadrilateral is not actually constructed; but the work of finding the required unknown part of the triangle is arranged in accordance with the diagram in Fig. 3, which shows A and O as coinciding. More particulars about this arrangement may be gathered from the example.

Given the two sides b, c of a spherical triangle and the included angle A, find the side a by means of the above-described apparatus.

Lay off with the scale of tangents when pivoted to the drawing board a distance along the initial direction which reads c; this fixes on the board the point D. Lay off towards A, as found on the margin of the board, a distance which reads b on the tangent scale; this fixes on the board the point E. On beam compasses set the distance DE, or mark it off upon a strip of paper. Next remove the scale of tangents and pivot to the board the scale of secants. Lay off on the secant scale, and beyond D, a distance which reads c; this fixes the point D_1. With the beam compasses centered at D_1, describe an arc. Lay off on the secant scale, still pivoted to the board (and revolving about O) a distance which reads b and note where it intersects the arc just drawn; this fixes the point E_1. The angle read off on the margin of the board is the side a.

The same construction taken in a slightly different order serves for finding A where a, b, c are the known parts.

We now take up the stereographic method. The problems to be considered are the same as those to which the gnomonic method applies. The advantage of the stereographic method lies in the fact that tan $\frac{1}{2}x$ does not approach infinity until x approaches 180°.

A plane tangent to the sphere at A, Fig. 4, contains the lines AD', AE' whose lengths are 2 tan $\frac{1}{2}c$, 2 tan $\frac{1}{2}b$. Imagine the triangle $O'D'E'$ revolved about $D'E'$ into the plane $AD'E'$. In the plane quadrilateral $AD'O'E'A$ thus obtained, $O'D' = 2\sec\frac{1}{2}c$, $O'E' = 2\sec\frac{1}{2}b$, $O'B = 2\cos\frac{1}{2}c$, $O'C = 2\cos\frac{1}{2}b$ and line $BC = 2\sin\frac{1}{2}a$.

With suitable scales and a protractor the quadrilateral $AD'O'E'A$ could be constructed and the required part of the spherical triangle could be thus determined; but the more practical arrangement is that shown in the figure where O' is made to fall upon A. Moreover, it is convenient to omit the factor 2 before tangents and secants.

Given b, c, A to find a by means of the above-described apparatus.

Lay off by means of the scale labeled tan $\frac{1}{2}x$, pivoted to the drawing board, a distance along the initial direction which reads c; this fixes a point D'. Lay off on this scale now directed towards A, as found on the margin of the board, a distance which reads b; this fixes on the board a point E'. On beam compasses set the distance $D'E'$, or mark it off upon a strip of paper. Next remove the tan $\frac{1}{2}x$ scale and pivot to the board the double scale shown in Fig. 2. Lay off with the

scale labeled sec $\frac{1}{2}x$, and beyond D', a distance which reads c; this fixes a point D_1'. With the beam compasses centered at D_1', describe an arc. Lay off on the sec $\frac{1}{2}x$ scale, still pivoted to the board (and revolving about O'), a distance which reads b and note where it intersects the arc just drawn; this fixes a point E_1'. Along the directions AD_1' and AE_1' locate the points B, C by laying off distances which read c and b upon the scale labeled $2\cos\frac{1}{2}x$. The reading of the distance BC upon the scale labeled $2\sin\frac{1}{2}x$ is the value of the side a.

The same construction taken in a slightly different order serves for finding A when a, b, c are the known parts.

In passing, it may be well to note that plane trigonometry applied to the triangles ADE and OED gives

$$\overline{DE}^2 = \overline{AD}^2 + \overline{AE}^2 - 2\overline{AD}\,\overline{AE}\cos A$$

$$= \overline{OD}^2 + \overline{OE}^2 - 2\overline{OD}\,\overline{OE}\cos a$$

$$\therefore \tan^2 c + \tan^2 b - 2\tan c\tan b\cos A = \sec^2 c + \sec^2 b - 2\sec c\sec b\cos a.$$

Noting that $\sec^2 = 1 + \tan^2$ and multiplying through by $\cos b\cos c$, we have, after transposing,

$$\cos a = \cos b\cos c + \sin b\sin c\cos A.$$

The same equation follows from the second method by noting that

$$\overline{D'E'}^2 = \overline{AD'}^2 + \overline{AE'}^2 - 2\overline{AD'}\,\overline{AE'}\cos A;$$

and

$$\overline{D'E'} : \overline{BC} = \sec\tfrac{1}{2}c : \cos\tfrac{1}{2}b$$

where $\overline{BC} = 2\sin\frac{1}{2}a$, and later on that

$$2\sin^2\tfrac{1}{2}a = 1 - \cos a,\ 2\cos^2\tfrac{1}{2}a = 1 + \cos a.$$

POLAR TRIANGLES.

Cases analogous to any of the above, but having sides and angles interchanged throughout, can be solved by the foregoing methods provided we first subtract all known parts from 180°, interchanging capital and small letters, and then after having solved this polar triangle, subtract the parts from 180°, and finally interchange the capital and small letters.

APPLICATIONS.

The methods already described may be used to advantage in some classes of plane-table work. To obtain the azimuth of the sun by one mechanical solution of the triangle, it is necessary that the telescope of the alidade be supplied with a vertical circle. The direction of the sun could be ascertained by means of a good watch, but the spherical triangle would then have to be solved for two of its parts.

The azimuth and hour angle of the sun or other heavenly body can be obtained from an observed altitude with sufficient accuracy for enabling one to lay down a Sumner line at the assumed or dead-reckoning latitude, and for ascertaining the variation of the magnetic needle at sea.

Tables of sunrise and sunset can be computed with great facility by means of the stereographic method. In fact, the true zenith distance (BC) of the rising or setting body is a constant for all latitudes and dates. The distance between pole and zenith at any particular latitude is constant for all dates. (That is, D', B and D_1' are fixed points for a given latitude, and about B, the zenith, a circle can be described with $2\sin\frac{1}{2}a$ as radius.) Since the polar distance of sun or moon never exceeds 120°, scales of moderate length will suffice for all possible cases.

Consider now the question of great circle sailing. The distance and initial course between two points specified by their latitudes and longitudes require the solution for two parts of a triangle whose given parts are two sides and the included angle. The longitude and latitude of the

vertex involve the solution of a right-angled triangle for two of its parts.

Since it seems to be almost certain that a proposed great circle track will in reality be sailed as a series of rhumb lines each terminating in or near the great circle, the methods of Mercator sailing will still be found useful. By aid of a set of meridional scales, problems in Mercator sailing can be worked with great facility. For, the board, the uniformly divided scales, and the T-square constitute an ordinary traverse table, and the departure is readily converted into difference of longitude through the equation

$$\text{Diff. long.} = \frac{\text{merid. diff. lat.}}{\text{true diff. lat.}} \times \text{departure.}$$

To do this, suppose the meridional difference of latitude to be laid off upon a uniform scale rotating about the pin or pivot. Let the true difference be laid off along, or parallel to, the initial line. Rotate the former scale until the T-square indicates that the point representing meridional difference is directly above that representing true difference. Now slide the T-square along until a point in the initial line is reached which denotes the value of the departure. The reading of the rotated scale directly above this point is the difference of longitude.

In conclusion, it should be said that the aim has been to use the drawing board proper merely as a surface upon which to locate points or lines temporarily, the accuracy of the work depending upon the fact that the scales and border of the board are not subject to any considerable atmospheric or temperature changes. R. A. Harris.

SCIENTIFIC BOOKS.

Zoology: Descriptive and Practical. By Buel P. Colton, A.M. Boston, D. C. Heath & Co. 1903. Part I., Descriptive, pp. x + 375. Part II., Practical, pp. xvii + 204.

Colton's 'Practical Zoology,' which was published seventeen years ago, did excellent pioneer work as a laboratory guide for secondary schools. This useful hand-book, revised and amplified, now appears in connection with an excellent descriptive zoology.

In the latter the author introduces each of the larger groups of animals by a description of a typical example, treating of its morphological and physiological characteristics and paying especial attention to its habitat, movements, senses, capture of prey, taking of food and manner of self defense.

Naturally, Arthropods, and particularly Insects, have a prominent place at the beginning, followed by a brief account of the Annulata, a somewhat longer description of the Mollusca and an extended discussion of the Chordata. Thereupon the Protozoa, Porifera, Cœlenterata, Echinodermata, Platyhelminthes, Trochelminthes and Molluscoidea are taken up in the order given. This is an excellent practical arrangement on the whole, though it might have been still better to have placed the Annulata and Echinodermata last and thus have preserved the ascending order throughout each of the two sections, for the sake of avoiding those misconceptions which are wont to arise in the mind of the beginner, to whom position in a text-book has a profound significance.

The strongest feature of the book is its broad treatment of animal life, in other words, its natural history. The author has a keen sense of what is interesting. His style is simple and direct, and the book is thoroughly readable.

The author did not cease to do pioneer work when he published his 'Practical Zoology' seventeen years ago. In the present book he makes free use of 'tho,' 'thru,' 'thoro' and their various compounds, while 'celom,' 'cecum,' 'hemal' and a few other words have been stripped of superfluous letters. He does not attempt to set right names like Amœba, which are apparently protected by their Latin form, but one is surprised that 'cœlenterates,' 'diaphragm' and a few other terms should not have been pruned. Spelling reform has much in its favor, and it must be introduced

by such gradual changes that a conservative public may not be offended. In the present instance the author's zeal does not seem to have led him to the point of giving offense, even though he may have laid himself open to the charge of inconsistency.

The book is comparatively free from minor errors or infelicities. On page 90, the skin of the earthworm is said to consist of three layers, the cuticle and epidermis, no mention being made of the derma. The cœlomic epithelium is omitted in the enumeration of the coats of the body wall. The description of the papulæ of the starfish as 'holes thru the aboral wall from which extend slender projections of the thin, soft lining membrane of the body cavity' needs considerable revision. The term 'digestive tube' is used when the cavity of the digestive tube, not its walls, is meant. The statement that in the echinoderms the digestive tube is 'distinct from the body cavity' is not very illuminating as it stands.

The illustrations are mostly well chosen, and about forty of them are original. It is unfortunate that greater care was not given to matters of detail in some of the original diagrams; thus the oviducts in the snake and the oviduct in the pigeon are each incorrectly represented as opening in front directly into the cavity of the ovary.

The capital press work of the descriptive part contributes in no small degree to the general excellence of the book.

Part II., on 'Practical Zoology,' is a great improvement over the original laboratory guide with which teachers in secondary schools are familiar. Full directions are given for the observation of living animals in the field and in captivity.

This part, however, might be made much stronger in respect to its teaching of morphology, without greatly increasing its size. For example, the attention of the student is not called to the cœlom of the earthworm either in connection with the dissection or in the study of the cross-section; and the term body-cavity is used loosely to apply to the enteric cavity in Hydra and to the cœlom in vertebrates. The directions for the study of the brain, particularly that of the rabbit, are exceedingly inadequate. We are told that the optic nerves 'directly enter the cerebrum'; and both diencephalon and midbrain are ignored. While this is in line with the popular notion that the brain consists of only two parts, it is not the sort of teaching that ought to find place even in a very elementary text-book. This part is remarkably free, however, from positive errors, and can be heartily recommended as a laboratory guide for secondary schools; the descriptive part is an elementary text-book of unusual merit.

JOHN H. GEROULD.

DARTMOUTH COLLEGE.

DISCUSSION AND CORRESPONDENCE.

METEOROLOGICAL OBSERVATIONS WITH KITES AT SEA.

TO THE EDITOR OF SCIENCE: Under the titles 'A New Field for Kites in Meteorology' and the above there were described in Vol. XIV. of SCIENCE experiments by the writer and his assistants of flying kites in calm weather from a tug-boat and from a transatlantic steamship. The demonstration that meteorological observations might be obtained at high altitudes, independently of the natural wind, over the greater portion of the globe and where no observations had been possible before, attracted the immediate attention of European meteorologists. The following brief accounts show that their application of this new method of meteorological research has been both extensive and successful.

The first to repeat the pioneer experiments of the late Mr. Sweetland and the writer during their voyage across the North Atlantic in 1901 were Messrs. Berson and Elias, of the Prussian Meteorological Institute, who, last August, made a voyage from Germany to Spitzbergen and back, achieving satisfactory results with their kites. Meanwhile Professor Köppen, of the Deutsche Seewarte, carried out analogous experiments on the Baltic Sea. About the same time, Mr. Dines, aided by grants from the Royal Meteorological Society and the British Association, employed

a small steamer for kite-flying off the west coast of Scotland, in connection with a fixed station on land. The vessel could be manœuvered at will, as in the writer's initial experiment in Massachusetts Bay, and the results published show that 38 records of the various elements were obtained at an average height of 6,000 feet, and that once an altitude of nearly 15,000 feet was reached, although, in this case, the upper kites and the recording instrument were lost, owing to breakage of the wire.

It is probably known to many of your readers that at several stations in Europe, and on Blue Hill in this country, balloon ascensions or kite-flights are made upon a specified day every month, in order to obtain meteorological data in the upper atmosphere simultaneously over a large region. In order to be independent of the natural wind, which is frequently unsuited to kite-flying, and to accelerate or diminish it as required, meteorological kites have recently been flown from steamboats on Lake Constance by Count von Zeppelin and Professor Hergesell on some of these term-days. Similar experiments upon the smaller lakes of Prussia and Russia have also shown that kites may be rendered nearly independent of the wind even in the interior of the continents.

A most remarkable campaign has been conducted by M. Teisserenc de Bort, who, with the aid of Scandinavian colleagues, established last summer a kite-flying station in Jutland, Denmark, where aerial soundings were made day and night, wind permitting, during nine months. After the termination of this work the apparatus was transferred to a Danish gunboat, and on a cruise in the Baltic Sea the following extraordinary results, which have just been communicated by the director, were obtained on five consecutive days: April 22, at an altitude of 9,450 feet a temperature of —14.°8 F. was found; April 23, at 13,500 feet, the temperature was 9.°1; April 24, at 4,660 feet, 38.°3. On April 25, an altitude of 19,360 feet, which is probably the greatest height ever reached by a kite, was exceeded, and an instrument on the lower portion of the wire, at a height of 7,415 feet, recorded 24.°4. In this flight the total length of the wire was 38,000 feet, and the upper 4,000 feet, with the highest registering instrument, broke away, but were recovered. On the morning of April 26 an altitude of 8,140 feet, with a temperature of 15.°2, was obtained and in the afternoon 13,320 feet with a temperature of 3.°2. Since the gunboat steamed only nine and a half knots, the kites could not be flown when there was a complete absence of wind.

These various experiments amply prove the practicability of the writer's project to investigate the atmospheric strata lying above the doldrums and trade-winds, by means of kites flown from a specially chartered steamship. This plan, which was outlined in Science, received the approval of the International Aeronautical Congress at Berlin last year, and an application for a grant to aid its execution is now before the trustees of the Carnegie Institution. Although the German, British and Scottish antarctic expeditions were equipped with meteorological kites, the reports received confirm the prediction of the writer that little use would be made of them during the voyages southward. On the vessel which the Baltimore Geographical Society sent last month to the Bahamas, Dr. Fassig, of the Weather Bureau, expected to fly kites, but, owing to the substitution of a schooner for a steamer, this could not well be done and, therefore, the kites were probably flown only at Nassau. It is to be hoped that Dr. Fassig has obtained observations of temperature and humidity in the trade-winds which, even if he did not succeed in getting through, owing to their becoming light above, will be of considerable value. These observations might serve as a starting point for the work of the expedition proposed by the writer, which would proceed across the equator and be capable of sounding the atmosphere to the height of four miles, notwithstanding the fact that winds either too light or too strong for the kites may be encountered when the steamer is stationary.

A. Lawrence Rotch.

Blue Hill Meteorological Observatory,
July 8, 1903.

SHORTER ARTICLES.

CRYSTALS OF OXALATE OF LIME IN PLANTS.

Agricultural and physiological chemists are generally of the opinion that one of the functions of lime in the nutrition of plants is to form an insoluble compound with oxalic acid and thus neutralize any toxic effect which this acid might have upon the plant tissues. Whether this theory is true or not it is quite certain that crystals of calcium oxalate are found in many plant tissues, while in some, especially those developing large quantities of organic acids, they are very abundant. A remarkable occurrence of such crystals has lately been disclosed by an investigation carried on in this bureau by Mr. B. J. Howard, chemical microscopist and histologist, on a sample of *Colocasia antiquorum,* the well-known taro, one of the principal food staples of Polynesia, brought to the bureau by Mr. W. E. Safford, assistant curator of the Bureau of Plant Industry, who is preparing a report on the economic plants of Polynesia. Mr. Safford stated that the intense burning and pricking sensation which is experienced on chewing parts of certain plants, such as the Indian turnip (*Arisæma triphyllum*) and the plant above mentioned, has been alleged to be due to the action of the acicular crystals of calcium oxalate which are said to exist in immense numbers, and which attach themselves to and enter, at least superficially, the mucous and other membranes with which they come in contact. I requested Mr. Howard to make a micro-chemical examination of this sample in order to determine whether or not such crystals were present. A simple trituration of the parts of the plant, as, for instance, a leaf, in water until a pulp is produced, is a sufficient preparation. A small portion of the pulp is placed upon a glass slide, a drop of water added (or water and glycerine) covered with a glass, and placed in the field of the microscope. When thus prepared, numerous very oblate spheroidal bodies were discovered within which were enclosed fine needles in a dense bundle. Some of these acicular and very long delicate crystals were dissolved in hydrochloric acid and were found to produce a precipitate of oxalate of lime when made alkaline by ammonia. The crystals of oxalate of lime produced in this way were not acicular as in the original case, but tetrahedral. While examining the field of the microscope, Mr. Howard observed in the case of one of the oblate spheroids the projection of these crystals into the ambient liquid with what seemed to be a considerable degree of force. This observation was so interesting that I requested Mr. Howard to prepare another portion of the material and see if the phenomenon be repeated. I first examined carefully the field of the microscope as prepared, but found no crystals, but a large number of spheroids above mentioned in which the bundles of long acicular crystals could be easily distinguished. These were surrounded by a membrane of quite uniform thickness, apparently of a cellular nature and probably consisting mostly of a cellulose—in other words, the crystals seemed to be encysted. During a period of observation of from five to ten minutes I did not notice the recurrence of the phenomena above described. Mr. Howard then observed the field in the microscope, and in a few minutes he said that one of the bombs had begun to discharge its projectiles. I immediately took Mr. Howard's place at the microscope and saw, for a period of five or ten minutes, a most remarkable display. Continual discharges were made from this bomb, the ends of the arrows spreading out as they emerged in groups of from four to ten. As these groups were finally separated from the bombs, they were discharged with considerable velocity into the ambient liquid, the bomb itself suffering a corresponding recoil. I did not keep an accurate account of the discharges made; but I would say that they would average not less than two per minute. Sometimes one or two needles only would be discharged, projecting rapidly, and then leaving the bomb finally with a sharp advance. At other times, as before mentioned, groups of from four to ten arrows would discharge at once. The field of vision in the vicinity of the bomb became partly covered with these long crystals, but the supply within the bomb did not seem to diminish materially. There

must have been many hundreds of these arrows in one single spheroid. Perhaps an oblate spheroid is not the best description of one of these masses. They resemble more a long capsule used in pharmacy with rather sharper ends, or the cigar-shaped balloon of an airship.

In looking for the cause of the discharge I suggested to Mr. Howard that it might be due to the contraction of the cell walls, due either to pressure of the cover glass or to drying. Mr. Howard suggested, and it is a very plausible reason, that it might be osmotic pressure due to the presence of certain mineral substances in the mother liquor. He proposes to test this theory experimentally by making a salt solution for mounting, to imitate, if possible, that within the bomb and thus to exclude osmotic pressure. Presumably, when left in the tissues of the plant the crystals are not discharged; at least, in the preparation which was under observation no free crystals were found until the bomb began to discharge the missiles; as the plant would grow older, however, and the osmotic conditions change, or the cell walls begin to dry, the discharges would begin to take place in the tissues of the plant. These bombs are bundles of crystals and are, of course, exceedingly small, and most of them would doubtless escape rupture during mastication, but a sufficient amount of them would discharge their arrows to account for the pricking sensations attending the mastication of this material.

Mr. Safford, who, while connected with the navy, spent some time among the Polynesians and made a study of the foods in common use, says that this plant is one of the principal food staples of the Polynesians and other Pacific islanders, who eat both the starchy rootstock, either baked or made into paste, and the young leaves which taste not unlike asparagus.

If the plant is not thoroughly cooked its acrid qualities remain in some degree. If thoroughly cooked they are destroyed. It is interesting to note that in cases where the leaves are chewed, either fresh or dried, the stinging sensation is not perceived until a few moments afterward, and in many cases it is not until the taro root has been eaten that the prickling sensation in the lining of the mouth and throat shows that it has not been thoroughly cooked.

Alocasia indica, a plant closely allied to the taro plant, is so acrid that the Pacific islanders resort to it only in cases of great scarcity of food. The disagreeable effects caused by these plants seem to be confined to the temporary prickling sensation of the mouth and throat. They are undoubtedly nutritious and are held in high esteem by the natives. The acrid principle in the manioc or cassava is at least partly due to the presence of hydrocyanic acid, and this is removed by cooking. It will be interesting to see if any of this poisonous acid is also found in the taro and *Alocasia indica.*

In the case of an Indian turnip lately examined by Mr. Howard, the capsules were found to be somewhat smaller and the crystals larger and shorter than those described. A drop of the sap of the taro, which was shown under the microscope to contain no crystals, did not produce a burning sensation when placed in the mouth. On the contrary, a drop of the juice of the Indian turnip which carried free crystals was quite active in producing the characteristic symptoms. These facts are additional evidence to support the theory at first mentioned.

While not yet fully established, there is presumptive evidence that the pricking and burning sensation experienced in masticating materials of this kind is mostly of mechanical origin.

H. W. Wiley.

THE SEMINAR METHOD IN NATURAL SCIENCES, ESPECIALLY IN ZOOLOGY.

Any one who has watched, for a number of years, the announcements of the lectures at German universities, will have noticed that the so-called 'Seminar-Ubungen,' 'Colloquia,' or 'Besprechungen,' and 'Wissenschaftlichen Gesellschaften' have been extended more and more, and now take often an important place among the courses offered by a department.

The desire of reaching the student better

or, more properly, of making a more lasting impression on his mind than is possible through the mere words of lectures was, of course, felt everywhere. Instead of being merely receptive, taking in lectures, and comparing them, at best, perhaps with some books, the student was to be put face to face with the problem, to be forced to be reproductive, and thus to be led to become productive.

The strong sympathy for the perfect liberty of the university student throughout Germany discriminated against any attempt at introducing school methods into the university. The natural sciences, of course, had developed their demonstration and laboratory methods. The other sciences, which are grouped together as mental sciences (the German 'Geisteswissenschaften'), then tried also to introduce practical studies. Thus the seminar was developed and has gained in favor ever since. To-day we find 'Seminarübungen' offered in the different branches of theological studies, jurisprudence, history, philology, philosophy, etc.

The word 'seminar,' as it is used at the universities to-day, means, in the first place, a room provided with tables for the students and containing the department library, especially the periodicals, models, charts and other study collections. The students become members of the seminar by paying a small 'contribution.' They receive a key to the seminar rooms, a table and the right of access to, and use of, all the books and apparatus of the institution. Each seminar has a janitor to keep things in order, and is open from 8 A.M. to 9 P.M. (for members only, of course). The students spend hours between lectures there, study, write their theses, etc. One of the finest and best equipped seminars of which I ever was a member is the geographical seminar of Professor Ratzel at Leipzig. It consists of four rooms; one is the study of the professor, one the study of his assistant, one is a large room which contains a very fine department library and the tables for the students, and in the fourth large, hall-like room all the numerous charts and maps, models and instruments are kept and may be used on special large tables. The fact that all but this last room open on an inner court of the university buildings shuts out the noise of the street, and the entire wing, being constructed to accommodate nothing but seminars on all its floors, is out of reach of the buzz of the students going to and coming from their lectures.

Besides the institution itself, the word seminar means also the 'colloquia' (or 'Besprechungen') and practical courses which are given in the institution and which are also called 'Seminarübungen' or simply 'Ubungen.'

The term 'Gesellschaft,' as used by certain professors, means similar work, but on the whole it corresponds more to what we call zoological club or journal club in America.

The chief advantage of all these courses is that they bring the student in closer contact with the professor. From my own experience I know how much benefit may be derived from this method. While studying over there I was fortunate enough to be admitted, for a number of semesters, to the seminar conducted by the professor of history of art (Professor Schmarsow, of Leipzig). Although these studies were out of my line, I gained so much there, and got such an insight into the methods and ways of thinking of the representatives of the mental sciences, that I have always been extremely thankful for this chance.

Quite recently seminars and seminarübungen have also been offered in the natural sciences, more especially in zoology and botany, at some of the German universities. The mental sciences, which have found so many of our methods useful for their purposes, render thus, as it were, their thanks and offer us a method which they have developed and which we might accept, perhaps, with some advantage.

The 'Practica' and 'Praktischen Ubungen' in natural sciences do not concern us here, they are simply laboratory courses independent of, or, better, separated from, the lectures. In many, perhaps most, cases the laboratory methods for the first years of study are decidedly better in this country. There are better instruments and apparatus at hand,

better laboratory and library facilities, more and better material to work with, and more personal instruction is given here than in Germany. The foreign methods—this may, perhaps, be said in their favor—make students more independent, because there are no strict directions to be followed, no note-books to be compiled. The professor gives you the animal, tells you the literature, and leaves you. You have to find out all about the creature yourself, and when he comes back you have to demonstrate to him what you have found. If that is not enough, he simply tells you that you have to keep on and he does not allow you to pass on to anything else until you have found and seen and drawn, yourself, everything that you can be expected to find. This method, of course, would not work with large classes. It can be used over there because the classes in zoology, botany and so on are always small and, besides, the students are more mature when they enter the university. Each professor has his individual laboratory method, which is just as good as anybody else's and which he does not care to publish. The general courses are always given by the head professor, because he is expected to have done so much special work that he is able to generalize. Thus he develops his methods from his special studies and carries them out, or has them carried out by his assistants. The younger 'docents,' on the other hand, give the advanced and special courses. They begin with their own specialties, widening their programs gradually, and thus develop special methods in their laboratory courses in their turn.

Where the classes are larger, and especially in the beginners' courses, the methods are often stricter and more school-like. In chemistry, physics, histology, etc., the methods are similar to those used in this country.

Let us see now what we may expect from a seminar in zoology, and in how many different ways it may be conducted.

I. There is, first, the simple method of reading a book with the students. This may be used as an introduction for beginners. Let us take, for instance, Darwin's 'Origin of Species.' The students read a chapter at home; at the seminar, the chapter will be discussed and questions asked. The animals mentioned by Darwin will be exhibited as specimens or, at least, in good pictures. In connection with these animals a great many questions will come up, and the instructor may ask a member to look up some special literature and report the next time. Of course the instructor has his plan, which he follows, and in harmony with which he directs all the discussions. Here and there he will have to interpret and show that certain views can not be held any longer, or that some authority, perhaps himself, does not agree with Darwin, and why. Thus the students are given several points of view on the subject and led to independent thinking.

In this way, without school-like recitations, the whole book will be gone through. While, in a course of lectures, the students will get the general idea of evolution, the seminar will show them how such an eminent investigator as Darwin worked and reasoned, and will give them a lot of detailed knowledge, and many inspiring thoughts for their own work besides.

II. Another seminar would be, for instance, 'Darwin, His Life and Work.' The instructor gives an outline of Darwin's life; each member takes one book or certain chapters, reads them and prepares a report for the meeting. Discussions, explanations and demonstrations follow. If the class is small, all of the numerous books can not be read by the members, and the instructor will have to pick out certain books or chapters which seem most important or interesting, and to give short reviews of the others himself.

There are a great many important books and pamphlets about which a student of zoology ought to know something and which he can not possibly read all by himself, especially if they be written in a foreign language. More than one book in German or French can not be expected from a student per semester or per year, but when each member of the seminar reads one book, something can be accomplished for the mutual benefit. The instructor gives the necessary explanations,

shows specimens, or at least pictures, charts and diagrams, performs experiments, if necessary, and directs the discussion.

III. The instructor prepares a list of books or papers which all relate to the same subject, and which he wishes to discuss with his students. He announces, say, a seminar on Darwinism, and either asks the members to report on some books of Darwin's, Wallace's, Häckel's, Romanes's, Weismann's, etc., or gives them some of the modern pamphlets dealing with evolution, heredity, variation, etc., for instance, Weismann's 'Germinal Selection,' Götte's 'Heredity and Adaptation,' Pfeffer's 'Transformation of Species,' some of Karl Pearson's papers, Cunningham-Weldon's controversy, some of Davenport's papers, etc.

IV. The instructor announces a seminar, say, on evolution. He makes out a list of topics relating to this special subject in such a way that they all together will more or less exhaust it. Such a list would be, for instance: Classification of organisms before and after Darwin. Geological and geographical distribution of plants and animals. Australia. Lamarck, Darwin, Wallace. Fertilization. Heredity. Variation. Species. Anthropoid apes. Pithecanthropus and the Engis, Spy and Neanderthal, Mentone and Cro-magnon skeletons. La Madelaine, Hallstadt, La Tène. Lake-dwellings, ancient and modern. Human races. Each member chooses one topic and makes himself acquainted with the main literature, prepares demonstrations and experiments, procures pictures and diagrams and works out a little lecture to be given before the seminar.

It is also a good idea to have these lectures written in the form of little essays which circulate among the members of the seminar after the lectures have been delivered and are, with their remarks on the margin, finally handed in to the instructor. In a later session the latter returns them and gives his criticisms both of the paper and the annotations.

V. In the same way, of course, a number of unconnected topics may be chosen. The instructor may want to have certain subjects brought up upon which the general interest happens to be focused, or he may have discovered certain deficiencies in the studies of his students which they would be thus obliged to make up. The same method will enable him also to complement, as it were, his lectures and laboratory courses by treating certain topics a little more fully than he can afford in his regular course.

VI. So far the teaching or imparting of knowledge has been in the foreground; but still another idea can be accepted as the leading principle: thinking, which leads to research. In other words, all the steps may be gone through which have led to some important discovery, or the history of a problem may be followed up to its latest aspects. Here, of course, the original papers will have to be used to a much larger extent, and especially all the pros and cons will have to be brought out. We may take, for instance, all the different steps which finally have led to the discovery of the cycles of the parasites of malaria. (Laveran, Golgi, Labbé, MacCallum, Ross, Grassi, Ziemann, Koch, Grassi and others.) Or, taking fertilization, we might have: The old spermatists and ovulists, Schwann's work on the cells, Leuckart's article on reproduction; Darwin, Weismann; Flemming, Van Beneden, Fol, Carnoy; Bütschli, O. Hertwig, Conklin, Mark, Wilson; Rückert, Häcker; Meves; Boveri; Loeb, Morgan, Wilson; Maupas and R. Hertwig; Calkins.

VII. The method can also be used in laboratory studies, each member making a certain preparation, constructing a certain apparatus, making a diagram or chart, etc. In this way two birds, or three, might be killed with one stone; the member in charge is obliged to study and acquire a certain skill and certain methods to do his part as well as possible; the other members get the benefit of the demonstration, and the laboratory finally acquires for its collection some dissection, microscopic preparation, some piece of apparatus, a chart, some lantern-slides, etc.

VIII. A plan may be adopted which amounts to cooperation. In this way a résumé of a certain question may be given, for instance, a paper on the present aspect of

the problem of gastrulation may be prepared and published. Each member takes one group, such as the different types of fishes, amphibia, reptiles and so on, goes over the literature and works out his account. The whole thing is then put together, added to and got ready for publication by the instructor.

IX. For the sake of completeness I wish to mention here the so-called zoological clubs or research clubs, where each member gives a piece of his own research, and the journal clubs. In the latter, each member takes one or a number of journals and gives a report of all the papers which have been published therein, which seem of a more general interest, or the papers are assigned to the members, or each member selects a specialty and reports in his turn on all the new papers in this line.

The advantages of the seminar method, it seems to me, are the following : (1) we are more able to give our students an idea of the many-sidedness of a modern science. A young student, after having heard the usual lectures and done his laboratory work, may be ready to believe that there are some more animals which he did not study and that some things and courses may be given which could not be offered, or he could not take; but on the whole he is apt to believe that, having done what was required of him, he knows now about what can be known on the subject in question. A seminar may have the not very pleasant but useful task of showing him how little he knows; that is to say, it can give the students an idea of the different points of view from which we may look at the very things which they have studied, the different ways in which we may combine them in order to find our way to a deeper knowledge, to gain a new truth. There is not always time and opportunity to discuss a question or attack a problem from several sides in a lecture; we can at best allude to that; and in the laboratory the main object ought always to be the most careful and exact observation of a few forms. In fact, perhaps, nothing but established facts or accepted theories and hypotheses ought to be brought up in the lectures, in the laboratory nothing but points which can be demonstrated or actually studied; the seminar is the place to give new ideas, to open new ways of looking at things, new connections and associations, to discuss uncertain points with their pros and cons, and to oblige the students to form an opinion of their own. In a seminar on Darwinism, for instance, we must offer and discuss, not only the points brought up by Nägeli, Eimer, Wolff, Dreyer, Götte, Cunningham, etc., but we must also see what Fleischmann has to say, and must let our students find his weak points.

(2) It seems to me that we often give, and have to give, certain things in our lectures which ought not to be given there. While I strongly believe that a careful study of anatomy or morphology is still and, after all, the only basis of all our further studies, be they physiological, psychological, bionomical and ecological or what else, it might, perhaps, be better to give in our lectures, aided by demonstrations, charts, models, lantern slides, etc., only the general outlines, the fundamental laws, certain views, certain points of the life history, habits, etc., and to leave details for a seminar. It is wonderful to develop before an audience the primitive forms of the embryo with the aid of models, clay and cloths of different colors, but when it comes to the details of the development of the vessels, muscles and the skeleton, the interest decreases equally with the student and with the teacher. In osteology the general features and arrangements of the bones in one animal, in a group or in the entire series of vertebrates, may profitably be explained in lectures; but the processes and their muscular attachments, the foramina and their passing nerves and vessels, and the details of the bones themselves, the peculiar twist, for instance, of femur and humerus, or of the ribs, are a rather dry subject for the hearer and unsatisfactory to lecture on for the instructor. What can not be covered by regular laboratory work could be treated in a seminar.

Especially helpful does the seminar appear in systematic zoology. Lectures on systematic zoology must always seem more or less unsatisfactory, even when supported by much demonstration material, because there are neces-

sarily too many names and too many, and often too fine, distinctive characters. In a seminar one group after another can be taken up. Each member studies one group, familiarizes himself with the characteristics, data, life histories, etc., and gives his demonstration. In a beginners' seminar the main groups may thus be treated; in an advanced seminar a small group may be studied more completely, and the members will have an opportunity to familiarize themselves with the main literature on the group, etc.

(3) A seminar can give the student an opportunity to see and compare more material than is possible in the laboratory course, and to see it better than is possible in a lecture or in the few minutes just before and after the lecture. The knowledge and faculty of observation gained by previous laboratory work enables the student to get a great deal out of the demonstration of comparatively much material which passes through his hands in a seminar. A student may have had, say a course in the dissection of an animal, the frog or the cat, for instance, and he may also have taken a course in comparative anatomy, and dissected a number of types such as *Amphioxus, Petromyzon,* a teleost, an amphibian, a reptile, a bird and a mammal. Then in a seminar it may seem desirable to study the different groups of fishes or amphibia more carefully. Each member makes a preparation of one system, or of all the systems of one animal, and gives his talk and demonstration on it. (Some of the better dissections may then be added to the museum.) Some skillful member may even be trusted with a dissection of a cæcilian, or the instructor may do that himself. Or the sexual organs, the nervous system, may be taken and studied in the seminar by means of demonstrations, microscopic slides and talks prepared by the individual members. Such a series for the sexual organs would be: *Petromyzon, Myxine* and *Bdellostoma; Amia, Lepidosteus* and *Acipenser;* Teleosts: *Perca, Salmo* or *Esox* for the male, *Perca, Esox* and *Salmo* for the female, *Serranus, Embiotocus; Protopterus* and *Ceratodus; Scyllium, Mustela lævis, Raja, Chimæra; Necturus, Cryptobranchus, Diemyctilis* and *Triton, Amblystoma, Plethodon, Rana, Bufo;* cæcilian; snake, turtle, lizard, crocodile; bird; *Echidna* and *Ornithorhynchus,* marsupial, rabbit, cat, bat, monkey, man.

(4) Each member may work his studies into a little written composition which afterwards circulates among all the other members, who may add remarks and ask questions, and is finally handed in to the instructor. This work, it seems to me, is much more valuable to the students than keeping note-books. As we all know, note-books are a very doubtful means of education. They do not prove that the student has mastered the subject, for we have often seen students coming together and one of them dictating what the others put down with little individual changes. In other cases, the temptation of copying from books is too great. Under these circumstances, it seems an enormous waste of time for the student to say in his imperfect way what others have said ten times better, more clearly and correctly, and what he ought to read, or to have read, along with his studies, just as well as for the instructor to spend his time in correcting them, which he ought to spend in doing original work. The seminar obliges the student to work a subject up, making himself thoroughly familiar with it, and then present it in a way which, while it is not original research, certainly means an individual representation, and, as such, is an important step towards independent work.

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BOTANICAL NOTES.

STUDIES OF WATER MOLDS.

DR. BRADLEY M. DAVIS, of the University of Chicago, has just issued a quarto pamphlet of thirty-two pages, accompanied by two large plates devoted to the oogenesis of certain species of water molds (*Saprolegnia*). The paper appears as one of the Decennial Publications of the University of Chicago, and is well worthy of appearing in this notable series. The treatment is modern, and Dr. Davis is quite inclined to cut across some of the views which have fastened themselves

upon the morphology of the water molds and their relatives. While it is impossible to summarize this paper here, the present reviewer wishes to express his hearty agreement with the conclusions reached by the author.

PROTOPLASMIC STREAMING IN PLANTS.

Dr. Alfred J. Ewart, of the Birmingham Technical Institute, England, has recently published an interesting book on the physics and physiology of protoplasmic streaming in plants which will attract the attention of cytologists and no doubt help to give a better idea of the mechanism of the streaming cell. The work is the outcome of a series of observations begun nearly ten years ago by the author and continued until quite recently. It takes up first the physics and chemistry of the subject, and this is followed by the physiology, and then by a theoretical and general discussion. A few results may be summarily indicated as follows:

The movement is generated in the protoplasm itself.

The velocity of streaming is largely dependent upon the viscosity of the protoplasm, and hence upon the percentage of water, being more rapid as the water is increased.

Gravity exercises little or no influence upon streaming in small cells, and only a very slight one in large cells.

High temperature affects streaming by decreasing the viscosity, and for each species of plant or cell there are minimal, optimal and maximal temperatures.

No special chemical changes are connected with the streaming of protoplasm.

In the strongest magnetic field little or no effect on the streaming is noticed, but electrical currents may accelerate or, when strong, stop the movement.

Strong light retards streaming, while weak light may accelerate it under certain circumstances.

The book is one which must commend itself to plant physiologists.

FORESTRY IN NEBRASKA.

Several years ago the Nebraska Park and Forestry Association was organized for the purpose of encouraging tree planting for economic as well as ornamental purposes. This organization has just issued a 'Park and Forestry Manual' which calls attention to the kind of work which such an organization may do for a community. This little manual of nearly one hundred pages contains many suggestive articles. There is first a short article giving the origin of arbor day, followed by one on the 'Forests and Forest Trees of Nebraska.' Following this is another on 'Tree Planting on Nebraska Prairies,' and then in succession 'Propagation of Forest Trees,' 'Raising Evergreens from Seed,' 'The Nebraska Forest Reserves,' 'Tree Planting in School Yards,' 'Trees and Orchards,' 'Success or Failure in Timber Claim Planting and Causes for It,' 'Home Adornment and Public Parks,' 'The Red Cedar for a Screen or Shelter' and 'Annotated List of Nebraska Trees.' This manual might well be imitated by similar organizations in other states.

C. E. Bessey.

University of Nebraska.

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*MODERN VIEWS ON MATTER.**

The Romanes lecture was delivered in the Sheldonian Theater, Oxford, on June 12, by Sir Oliver Lodge, F.R.S., principal of the University of Birmingham, the subject being 'Modern Views on Matter.'

The lecturer began by saying that he would discriminate between theses which were generally accepted by physicists and speculative opinions or hypotheses which were now being thrown out on the strength of experimental evidence of an at present incompletely conclusive, but very suggestive, character. The first thesis was that an electric charge possessed the fundamental property of matter, called mass or inertia, and that if a charge were sufficiently concentrated it might represent any amount of matter desired. There were reasons for supposing that electricity

* From the London *Times*.

existed in such concentrated small portions, which were called 'electrons,' and could either be associated with atoms of matter, to form the well-known chemical ions, or could fly separate, as was observed in the cathode rays of vacuum tubes, and in the loss of negative electricity when ultra-violet light fell upon a clean negatively charged surface. The lecturer went on to say: The hypothesis suggested on the strength of these facts is that the atoms of matter are actually composed of these unit electric charges or electrons, an equal number of positive and negative charges going to form a neutral atom, a charged atom having one electron in excess or defect. On this view a stable aggregate of about 700 electrons in violent orbital motion among themselves would constitute a hydrogen atom, 16 times that number would constitute an oxygen atom, and about 150,000 would constitute an atom of radium. The attractiveness of this hypothesis is that it represents a unification of matter and a reduction of all material substance to a purely electric phenomenon. The strongest argument in its favor is that mass or inertia can certainly be accounted for electrically, and that there is no other known way of accounting for it. If matter is not electrical, then there are two distinct kinds of inertia which exactly simulate each other's properties. Assuming this electrical theory of matter, that the atoms are aggregates of electric charges in a state of violent motion, two consequences follow. One of these consequences depends on the known fact that radiation or light, or an ether wave of some kind, is emitted from any electron subject to acceleration; consequently the revolving constituents of an atom must be slowly radiating their energy away, must thus encounter a virtual resistance, and must in that way have their velocity increased. The second consequence is that when the speed of an electrified body reaches that of light its mass becomes suddenly infinite; and in that case it appears not improbable that a critical condition would have been reached at which the atom would no longer be stable, but would break up into other substances. And recently during the present year a break-up of the most massive atoms has been observed by Rutherford, and has been shown to account for the phenomenon of radio-activity, some few of the atoms of a radio-active substance appearing to reach a critical stage, at which they fling away a small portion of themselves with great violence, the residue having the same property of instability for some time, until ultimately it settles down into presumably a different substance from that at which it started. The matter flung away appears to be a light substance not very different in atomic weight from hydrogen or helium, and it is surmised that possibly certain chemical inert elements may be the by-products of radio-activity; and that this process of dissociation of the atom may constitute the evolution of the chemical elements, such as has, on theoretical grounds, already been speculatively surmised. An analogy, the lecturer said, may be drawn between this supposed gradual collapse of an atom and the contraction of a nebula, which at certain stages becomes unstable and shrinks off a planet, the residue constituting an extremely radio-active mass or sun. But, whereas the astronomical changes observed in cosmic configurations of matter occur in a time reckoned in millions of years, the changes to be expected in the more stable atoms would seem likely to require a time reckoned in millions of millions of centuries; but, nevertheless, according to known laws, and on the hypothesis of electric constitution, the change seems bound ultimately to occur; and so a state of flux and decay is hypothetically recognized, not only in the stars and planets, but in the foundation-stones of the universe, the elemental atoms themselves. A process of regeneration, however, is also thinkable, and would occur if the separate electrons were ever to aggregate themselves together by their mutual attractions into fresh material. And, inasmuch as the life of a highly radio-active substance must be very limited, being, perhaps, not more than a few thousands of years in some extreme cases, it appears necessary to assume that some such regenerative process is constantly at work, and that, just as we have

suns of various ages and exhibiting the process of evolution in different stages, so it may be that the progress of research will lead us to recognize the existence of atoms of matter in like case, some recently formed, and some very ancient; and the whole argument seems to lead to an atomic astronomy of surpassing interest.

SCIENTIFIC NOTES AND NEWS.

M. Amagat, of the Paris Polytechnic School, has been elected a member of the Paris Academy of Sciences in the section of physics, and Dr. H. A. Lorentz, professor of physics at Leiden, has been elected a correspondent in the same section.

Lord Kelvin and Lord Lister have been elected honorary members of the Royal Society of New South Wales.

Lord Lister, in recognition of his 'long and valuable services to the country and particularly to surgery by the discovery and application of the antiseptic treatment,' has been admitted to the honorary freedom of the Merchant Taylors' Company, London.

Dr. W J McGee has been appointed chief of the Department of Anthropology and Ethnology at the Louisiana Purchase Exposition.

Dr. Philip Henry Pye-Smith, F.R.S., has been reelected chancellor of the University of London.

Dr. G. von Escherich, professor of mathematics, has been made rector of the University of Vienna.

The University of Groningen has conferred an honorary doctorate of mathematics and astronomy on Dr. C. Easton, director of the Observatory at Rotterdam.

Dr. F. Hofmann, professor of experimental hygiene at Leipzig, has celebrated the twenty-fifth anniversary of his professorship.

Dr. B. E. Livingston, instructor in plant physiology in the University of Chicago, has been granted a research scholarship in the New York Botanical Garden, beginning September 1, 1903.

For the Michigan State Geological Survey Dr. A. W. Grabau will continue his studies of the Dundee and Traverse Limestones of the state, which are proving of great economic value. The survey has just issued a report on Portland cement, clay and coal, and soon expects to issue one on gypsum by Professor G. P. Grimsley. Dr. F. E. Wright, of the Michigan College of Mines and Geological Survey, is conducting some investigations of the copper-bearing rocks of the Porcupine Mountains. Mr. Leon J. Cole has prepared a study of the growth of the St. Clair Delta. Mr. Robert Muldrow is mapping the quadrangle around Detroit for the U. S. Geological Survey in conjunction with the State Survey. Mr. Lane's papers on the water supply of Michigan being entirely exhausted, the State and U. S. Geological Surveys are actively engaged in preparing for revised and extended editions. Messrs. R. E. Horton, W. M. Gregory and W. F. Cooper are engaged in this work.

The present board of visitors of the Royal Observatory, Greenwich, is composed as follows: Sir W. Huggins, Professor H. H. Turner, Professor W. G. Adams, Professor J. Larmor, Sir J. N. Lockyer, Lord Rayleigh, Lord Rosse, Sir A. Rücker, Sir W. Abney, Sir R. Ball, Professor R. B. Clifton, Dr. J. W. L. Glaisher, Professor G. H. Darwin, Rear-Admiral Sir W. J. L. Wharton, Mr. W. D. Barber.

Dr. J. E. Dutton and Dr. J. L. Todd, principals of the Trypanosoma Expedition of the Liverpool School of Tropical Medicine, have returned to England from Senegal, where they have been investigating trypanosomiasis, a human disease similar to the tsetse fly disease which is the chief cause of mortality among the horses.

The following British civil list pensions have geen granted: £100 to Mrs. Adelaide Fanny Eyre in consideration of the services of her late husband, Mr. Edward John Eyre, the Australian explorer and Governor of Jamaica; £120 to Mrs. Zare Elizabeth Blacker in recognition of the services of her late husband, Dr. A. Barry Blacker, who lost his life

through his devotion to medical research; and £105 to Mr. James Sully in recognition of his services to psychology.

MR. WILLIAM E. DODGE, chairman of the committee appointed by Mayor Low to raise an endowment fund for Cooper Union as a memorial to Abram S. Hewitt, sent to the mayor a check for $211,310, which has been transferred to the treasurer of Cooper Union. Twenty-one persons contributed to the fund, including Andrew Carnegie, $55,000; John D. Rockefeller, $50,000; J. Pierpont Morgan and William E. Dodge, $25,000 each; George F. Baker, Jacob H. Schiff and Henry Phipps, $10,000 each.

THE Lord Mayor of Belfast is chairman of a committee that will present to Queen's College, Belfast, a portrait of Dr. J. W. Byers, professor of the diseases of women and children.

THE Misses Gladstone have presented to the Royal Institution the portrait of the late John Hall Gladstone, formerly professor of chemistry in the Institution.

DR. F. BAUER, docent in the Munich Institute of Technology, has been killed by an Alpine accident at the age of thirty-three years.

DR. P. H. KELLER, honorary professor of physics at the University of Rome, has died at the age of seventy-seven years.

SIR GEORGE STOKES bequeathed his scientific apparatus to the University of Cambridge. It has been distributed among the Chemical, Physical and Mineralogical Departments.

THE library of the late Professor Schade, formerly director of the surgical clinic of the University of Bonn, has been presented to the clinic by his widow.

MRS. MARY E. RYLE has given $130,000 toward the construction of a new library building at Paterson, N. J.

THE Royal Academy of Belgium offers next year its Charles Lagrange prize of the value of 1,200 francs for a paper adding to our mathematical knowledge of the earth. It also offers the Theophile Gluge prize of the value of 1,000 francs for the best work on physiology. The following year it offers its De Selys Longchamps prize of the value of 2,500 francs for the best original work on the fauna of Belgium. These prizes are open to foreigners.

THE bill which passed the Michigan legislature, and was supported by the Michigan Academy of Science, providing for a biological survey of the state under the supervision of the state geologist, unfortunately failed to receive the approval of the governor. The state geologist was called east just at the close of the legislature by the death of his brother, Mr. L. P. Lane, of the Statistical Department of the Boston Public Library.

THE Sanitary Institute of Great Britain held its twenty-first congress at Bradford during the second week of July under the presidency of Lord Stamford.

THE Association of German Engineers met at Munich at the end of June.

THE sixth International Congress of Psychology, which was to have met in Rome in the autumn of 1904, will be postponed to the spring of 1905 to avoid conflict with the sixth International Congress of Physiology which meets at Brussels in the autumn of 1904.

AT a meeting held recently in Manchester it was unanimously resolved that it is desirable to hold an international exhibition in that city in 1905.

A STOCKHOLM correspondent writes, on July 5, to the London *Times*, that the Norwegian steamer *Frithiof*, chartered by this expedition, will arrive from Tromsö in a few days for outfitting. It is expected that the ship will be ready to start about the middle of August. Lieutenant Blom, of the Swedish navy, who two years ago accompanied the trigonometrical survey expedition to Greenland, has been appointed second in command. The young Swedish zoologist, Baron Klinckowström, will also accompany the *Frithiof*. Three expeditions are thus now hurrying to the rescue of de Nordenskiold and his companions. The Swedish, on board the *Frithiof;* the Argentine, in the *Uruguay;* and the French, in the *Français*.

THE official report of Professor Drygalski on the German Antarctic expedition was

published on July 10, in a special supplement of the *Imperial Gazette.* According to Reuter's Agency the report begins with the start from Kerguelen on January 31, 1902. The ship reached the Heard Islands on February 3, from which point the regular South Polar voyage began. The *Gauss* proceeded in a southeasterly direction towards a land the existence of which was reported by the Wilkes expedition, but placed in doubt by the Challenger expedition. After a rough voyage the first drift ice was reached in February 13 at 61° 58′ south latitude, 95° 8′ west longitude. From the 18th to the 22d of February, 1902, an effort was made to make a good push southward, but this was stopped, the *Gauss* being fast caught in the ice and thus compelled to lie up for the winter. Professor Drygalski christened the bay in which the *Gauss* lay Posadowski Bay, and the ice-free volcanic peak, 1,200 feet high, on the south side of the *Gauss* was named the Gaussberg. On February 8, 1903, the *Gauss* was set free by a strong easterly wind, and went along the northern edge of the western ice, which she finally lost sight of on February 19, 1903, in 65° 32′ south latitude and 87° 40′ east longitude. She then drew near to the ice again, and was held fast from March 6 to March 14 for a second time. She again managed to reach the open sea, in which she advanced as far as 64° 51′ south latitude and 8° 14′ east longitude. Traveling became difficult owing to the ever-growing length of the nights. On April 8, 1903, it was determined to turn back northward at 64° 58′ south latitude and 79° 33′ east longitude. On April 8 Kerguelen was passed, and on June 9 Simons Town was reached, all well.

'Furthest South with the Discovery,' Lieutenant Shackleton's narrative, with illustrations of the first eighteen months' work of the National Antarctic Expedition under Captain Scott, has been acquired for publication by the *Illustrated London News.* The first part of the narrative was promised for June 27, as a supplement to the ordinary number of the *Illustrated London News.*

The London *Times* states that at the invitation of Lord Lister and the governing body of the Jenner Institute about 100 gentlemen traveled down to Elstree on July 3 to inspect the new antitoxin department of the Jenner Institute of Preventive Medicine. With Lord Lister were Lord Iveagh, Sir Michael Foster, Sir Henry Roscoe and Mr. J. Luard Pattisson, members of the governing body, and Dr. Macfadyen, chief bacteriologist. The resident staff, consisting of Dr. George Dean, Dr. Todd and Dr. Petrie, received the party at Elstree and conducted them over the establishment, which is devoted to the preparation of antitoxins on a commercial scale, and to the experimental investigation of questions connected with immunity. This department of the institute's work used to be carried on at Sudbury, but, in consequence of compulsory disturbance to make room for the Great Central Railway, it has been transferred to Queensberry-lodge, near Elstree. The institute is fortunate in having secured so good a site. The place was formerly a breeding stable, and it contains first-rate accommodation for 36 horses. Each animal has a loose-box of the most modern and sanitary type. There was, in addition, a small house, which affords room for two members of the staff and is surrounded by a large garden and some 23 acres of meadowland. The whole stands high in a healthy, isolated and wholly rural situation. A suite of laboratories has now been added. They are most conveniently arranged and constructed according to the latest requirements, with papyrolith floors having rounded corners, glazed adamant walls, white tiles and large windows. In the garden are isolated houses for the smaller animals. The visitors, who inspected the whole establishment with the interest of experts, were greatly pleased with the construction and arrangement of the premises. They were particularly struck with the healthy and well-kept-up appearance of the horses, and with the cleanliness and order maintained in every part of the establishment.

Reuter's Agency reports that the Liverpool School of Tropical Medicine has received a report from the Suez Canal Company on the

subject of the result of Major Ross's recommendations for the improvement of the sanitary conditions at Ismailia, with special reference to the campaign against mosquitoes. Major Ross, accompanied by Sir William MacGregor, went out to Ismailia in the autumn of last year to study the question of the prevalence there of malaria. Major Ross was sent out by the Liverpool School of Tropical Medicine, at the special request of Prince d'Arenberg. The report begins by referring to a statement made quite recently by the principal medical officer of the Sudan to Major Ross that the sanitary state of Ismailia is now much improved. The secretary-general proceeds to say that since the visit of the expedition of the school to Ismailia in September last several important drainage works have been undertaken, including the filling up of water puddles, and that a special service had been created for the purpose of supervising this work, specially charged with the duty of pouring oil on the pools and disused wells, doing away with marshes, puddles, etc., existing in and near the residential quarters of Ismailia. On the other hand prophylactic measures, such as gratuitous distribution of quinine, 'liqueur de Fowler,' have been continued without interruption since April, 1902. In December the number of cases of fever had decreased in a most marked manner compared with preceding months and the corresponding month in the previous year. The secretary-general states that this diminution in fever has been maintained up to the date of writing—namely, July 2 in the present year. Thanks to systematic oiling of pools and to the unceasing watch kept over all likely places where larvæ can be hatched, the ordinary mosquitoes of the genus culex and stegomyia have been annihilated almost absolutely, and even in the worst period of the hot season it has been found possible to dispense with the use of mosquito nets. The secretary-general ends with a testimony to the value of the work of the expedition, and says they have every hope that the assistance rendered by Major Ross will result in the complete abolition of malaria from the town of Ismailia.

THE U. S. Geological Survey has just issued a list, complete up to June, 1903, of its serial publications, consisting of Annual Reports, Monographs, Professional Papers, Bulletins, Mineral Resources, Water-Supply and Irrigation Papers, Topographic Atlas of the United States, and Geologic Atlas of the United States. Monographs, topographic sheets and geologic folios are sold at cost of publication —topographic sheets (of which indexes, free on application, are published from time to time) are sold at 5 cents each, or $2 per 100 in one order; geologic folios usually at 25 cents each; the other publications are distributed free. The latest professional papers are: No. 15, 'Mineral Resources of the Mount Wrangell District, Alaska,' by W. C. Mendenhall and F. C. Schrader; No. 16, 'Carboniferous Formations and Faunas of Colorado,' by G. H. Girty; No. 17, 'Preliminary Report on the Geology and Water Resources of Nebraska West of the One Hundred and Third Meridian,' by N. H. Darton; No. 18, 'Chemical Composition of Igneous Rocks expressed by means of Diagrams, with reference to rock classification on a quantitative chemico-mineralogical basis,' by J. P. Iddings. The latest bulletins are: No. 213, 'Contributions to Economic Geology, 1902,' S. F. Emmons and C. W. Hayes, geologists in charge; No. 214, 'Geographic Tables and Formulas,' compiled by S. S. Gannett; No. 215, 'Catalogue and Index of the Publications of the United States Geological Survey, 1901 to 1903,' by P. C. Warman; No. 216, 'Results of Primary Triangulation and Primary Traverse, Fiscal Year 1902–3,' by S. S. Gannett. The latest water-supply papers are : No. 80, 'Relation of Rainfall to Run-off,' by G. W. Rafter; No. 81, 'California Hydrography,' by J. B. Lippincott; Nos. 82, 83, 84, 85, 'Report of Progress of Stream Measurements for the Calendar Year 1902,' by F. H. Newell; No. 86, 'Storage Reservoirs of Stony Creek, California,' by Burt Cole. The latest geologic folios ready for distribution are: No. 90, 'Cranberry, Tennessee'; No. 91, 'Hartville, Wyoming'; No. 92, 'Gaines, Pennsylvania, New York'; No. 93, 'Elkland-Tioga, Pennsylvania.' All the

above mentioned geologic folios are sold for 25 cents each. Application for any and all publications should be made to the Director, U. S. Geological Survey, Washington, D. C.

A note in the *British Medical Journal* states that the opening up of Central and Eastern Africa has revealed the fact that instead of zebras being nearly extinct, these animals exist in large numbers on the banks of the Tama River and in the province of Ukamba. Unlike horses and cattle, they are proof against horse sickness and the fatal tsetse fly. At the present time, for land transport in war, mules are almost universally employed, and they are used for the carriage of mountain batteries. Professor Cossar Ewart has at Penycuik since 1895 been endeavoring by zebra-horse hybrids to 'evolve' an animal that shall be superior to the mule for the purposes for which that animal is usually employed. There are three kinds or types of zebras—namely, Grevy's zebra of Shoa and Somaliland, the mountain zebra (equus zebra), once common in South Africa, and known as the common zebra, and the widely-distributed Burchell group of zebras. The zebra-horse hybrids were obtained by crossing mares of various sizes with a zebra stallion, a Burchell's zebra; and the new animals get the name of 'zebrules.' They seem excellently adapted by their build and general make, as well as by the hardness of hoof, for transport purposes and artillery batteries. The zebra striping is often distinct, though in color they more generally resemble their dam. They stand fourteen hands high, with a girth measurement of sixty-three inches. Their temper seems to be better than that of the ordinary mule, and they are exceedingly active, alert and intelligent. The Indian government is giving them a trial in Quetta for mountain battery work, and they are being put, also, to a practical test in Germany.

UNIVERSITY AND EDUCATIONAL NEWS.

The Royal Geographical Society has appropriated £200 a year for five years, and the general board of studies of Cambridge University the same sum for a School of Geography at the university.

Professor W. N. Ferrin has been elected president of the Pacific University at Forest Grove, Oregon.

Dr. Allen J. Smith, present professor of pathology in the University of Texas, has been elected professor of pathology at the University of Pennsylvania, in succession to Dr. Simon Flexner, director of the Rockefeller Institute, New York.

Mr. Edgar James Swift, A.B. (Amherst, 1886), who has held a fellowship at Clark University for the past two years and has just taken an examination for the doctor's degree there, has been appointed professor of psychology and pedagogy in the Washington University at St. Louis.

Mr. M. E. Stickney, of Harvard University, has been appointed instructor in botany in Denison University to succeed Mr. W. W. Stockberger, resigned.

The following appointments have been made at McGill University: Dr. J. G. McCarthy, to be assistant professor of anatomy; Dr. J. T. Halsey, to be assistant professor of pharmacology and therapeutics; Dr. R. A. Kerry, to be lecturer in pharmacology and therapeutics; Dr. S. Ridley Mackenzie, to be lecturer in clinical surgery; Dr. John McCrae, to be lecturer in pathology; Dr. D. A. Shirres, to be lecturer in neuro-pathology; Dr. D. D. McTaggart, to be lecturer in medico-legal pathology.

At University College, London, Dr. Page May has been appointed lecturer on the physiology of the nervous system, and Mr. J. H. Parsons, lecturer on physiological optics.

A chair of agricultural botany has been established at Rennes, with M. Danniel as professor.

Dr. Emil Kraepelin, professor of psychiatry at Heidelberg, has been called to Munich.

Dr. W. Lossen, professor of chemistry at Königsberg, has retired.

Dr. Carl Hugo Huppert, professor of medical chemistry at the German University of Prague, will retire at the end of the present semester.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, JULY 31, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*SPECIALIZATION IN EDUCATION.**

THE past few years have witnessed profound changes in the industrial conditions of our people, changes which, to many, are of deep portent. The concentration of wealth, the centralization of power, the development of monopolies, all have seemed to menace the equilibrium of our nation, and dire have been the prophecies of evil. But, with all these changes, with oil trusts and steel trusts and other trusts innumerable, have also come national supremacy in commerce, the creation of vast wealth, and an advancement in well-being. The industrial world, like the rest of the great world of nature, is never at rest. Every new invention of labor-saving machinery, every new discovery of importance, brings unhappiness and misery to some, but increased happiness and pleasure to many others. So too, who shall doubt but that the present monopolistic movements, the trusts and the mergers, when we shall have learned to guard that which is good and prevent that which is bad, will result in greater benefits to mankind and a higher civilization? To check the greed of trusts there are labor unions, to check the lawlessness of labor unions there will be consumers' unions, and over all there will be social laws to harmonize dissonance. Man,

* Read before the Society of Sigma Xi, Ohio State University, June 22, 1903.

more than any other animal, is social and gregarious, and the evolution of laws for the best interests of the race is as certain as the evolution of the organic world.

The concentration of forces in the industrial world, by whatsoever name we call them, is an expression of a definite social law. Many of my hearers will remember when every village had its own shoemaker, its butcher and baker and candlestick maker, all laboriously and with wasted energy doing those things which are now being done by scores of producers. The trusts or combinations may and will do things cheaper and better, because they concentrate in labor and material and time, all of which are possible because of increased specialization.

But it is a grave problem to all of us how far such specialization and concentration shall be permitted to go, that they may not outrun control, that they may not result in the subjugation of the weaker and their undue dependency upon the greed of the leaders of the industrial forces. When wealth and power have become perpetual, and poverty insurmountable, then would trusts and monopolies be intolerable and dissolution imminent.

Of such results, however, there is less probability than ever before in the world's history. The fountain of civilization is constantly bubbling up afresh to replace that which is foul and effete. Never before has there been less danger of stratification in our social organism. In the past history of life upon our earth it has been a law that the highest organisms of one epoch have developed, not from the dominant organisms of a preceding epoch, but from the middle classes, if I may apply such a term to them. From the farm and the work shop will come the leaders of the next generation, even as those of the present generation are, for the most part, of similar origin.

With every succeeding generation of men, as of other animals, the summit of evolution is gradually becoming higher. The way toward success is longer, but our strides are greater. Specialization is an inviolable law of nature, to which man is no exception, physically or psychically. How shall we recognize this in education? How shall we determine that which is real and avoid that which is unreal?

It must be apparent to all that our modern industrial activities are having a profound influence upon our systems of education. Or is it largely because of our improved methods in education that America is attaining its great commercial importance at the present time? A new generation has grown up since technical schools of agriculture have been established throughout our land, and technical and professional schools of all kinds have improved in a most extraordinary way during the past twenty years. The engineer is no longer a country surveyor; the physician is no longer one who turns from the plow or anvil to pills and powders with a few months' interim of perfunctory lectures; the lawyer is no longer graduated from the village law office. President Draper has recently deplored the passing of the family doctor and the coming in his stead of the specialist. He regrets that the man, the counselor and friend is merging into the cold, unsympathetic scientist. But who is there of us, when danger is imminent, that would not rather choose that same unsympathetic scientist, skilled and skilful in all that goes toward success? Who would choose the village-educated lawyer to fight a powerful trust? Special knowledge and special skill the world must have and the world will have wherever possible, and special skill is possible for every one, even though it be in nothing more than the sharpening of a jack-knife. Is there any one who doubts this? Is there

any one who prefers inferiority in a multitude of things rather than eminence in a few things or in one thing? It is not, then, a question of the desirability of special skill, but rather of how that special skill may be best attained.

I have no patience with those who think, because a student prefers to spend months or years of study in the bacteriological laboratory when he might have been devoting his attention to Greek mythology, that he is actuated by a commercial spirit, that, because he is doing something well which he will afterwards find useful, he is mercenary. Thirty years ago, however, the average college professor would have been shocked by the bare suggestion that his pupils desired to make any practical use of the knowledge he imparted, or that the single inelastic college course of those days was not the best preparation for any vocation in life.

There is still a prevalent belief, even though much modified from that of former days, that the general training of the intellectual powers should continue through at least three, if not four, years of college life —that specialization should not begin early, if one wishes to accomplish the most in life. That late specialization is not the best in all professions the world has long conceded. What eminent musician has there been who did not begin his musical training while yet a child? What great artist has there been who first decided upon his life's work after graduation from a college course? How many novelists of wide reputation are there who have been college graduates even? How few, indeed, are the great leaders in commerce, science or the arts who did not begin their distinctive pursuits early in life. Ask an Agassiz, a Darwin or a Huxley, or any one of our able naturalists, when he first began the study of nature, and he will reply that he was always a naturalist. Is it probable that such men would have been greater men had they devoted four years of their life to the humanities alone? Is the great musician less successful because his training may have been at the expense of Greek, mathematics or chemistry? It is true, indeed, that such men are often one-sided, cranky, as the world calls them, and that undue specialization has robbed them of much of the sweeter part of life, has put them out of joint with the world, has often left them, as Agassiz has said, with no time to make money, but I believe that it is better to have cranky specialists than not to have them at all. Away with the idea that such men are always born great; if early specialization is good for men with great powers, it is better for those with small powers. Precocity may be a sign of greatness, but I believe more often greatness is the result of precocity, the result of early concentration before the plasticity of youth is irrevocably gone. We cheerfully admit that the violinist *must* begin his special training while yet his muscles are plastic. Is the mind less plastic than the muscles, and is there not as great need that it should be molded early? You can not teach old dogs new tricks, nor is it often possible to teach a man new tricks after he has become matured.

Very recently a Chicago author has published a book in which he endeavors to prove, from the testimony of many prominent men of business, that a general college course is detrimental to success in a business career, and it is well known that such successful men as is Carnegie have given assent to such views. Like all such generalizations there may be both truth and falsity in this one. For many men, and by no means the poorer men, I firmly believe that a general college course is detrimental as preparation for a business career, while to all a special education and a fixed motive in their education are of

benefit. We clearly recognize to-day that the object of higher education is less the acquisition of knowledge than the acquisition of power to use knowledge, and any education which neglects those powers most necessary in a given vocation is sure to be of harm, either negatively or positively.

As a rule, I believe that the college education materially helps towards the largest success in life only when that education is to a greater or less degree a special education. Some will benefit by a wide cultural training, others will not. A broad man may benefit by a broad training; the narrow man must be content with a narrower preparation to fit him for a narrower path in life. A four years' course in Greek or paleontology will not enable the apprentice to wipe a joint nearly as well as would a four weeks' laboratory course under a master plumber. But a too broad training is, I believe, better than a too narrow one. One so trained is more apt to make a better citizen though he makes fewer dollars. A more rational system, and one towards which the educational world seems rapidly tending, is to neglect neither the general nor the special. The one fundamental principle in the teaching of science at the present day is the laboratory, the cultivation of skill in doing things rather than in knowing about things. In all the technical professions this is assumed, even though it may be carried to an undue extent. At least we are all agreed that the one chief object of education is to make the student think, and then do. How much does the general college education do this for many pursuits in life?

Professor Thorndike, in a recent number of the *Century Magazine*, has given an interesting analysis of the careers of the Phi Beta Kappa scholars during the past sixty years. He has shown that during these years the proportion of those who have followed the so-called learned professions of law, the ministry, medicine and teaching has remained nearly uniform at about sixty-five per cent., but that in some of these vocations the proportions have increased at the expense of those in others. The percentage of those scholars following the legal profession has advanced materially, while there has been a marked falling off in the proportion of those who have become clergymen. In the percentage of teachers there has been a striking increase, while that of physicians has increased from five to about seven per cent. Membership in this society in the past has been conferred upon those students who have attained a high stand in the so-called cultural studies especially, professional students being excluded even yet. What is more reasonable to suppose than that such students would of choice seek those pursuits for which their training has more especially fitted them, and in which they have attained scholarly success? The decrease in the number of those seeking the ministerial calling has been dependent upon entirely different causes, though I will venture to say that the percentage of Phi Beta scholars following this profession is larger than among other graduates with similar training. While there are so many more such scholars among our teachers than formerly in the profession of medicone, I doubt not there are proportionally fewer than there were fifty years ago. The increase of but two or three per cent. for this profession is very suggestive, and even this increase is more apparent than real. In recent years the requirements for the Bachelor of Arts degree have everywhere been much liberalized, and the Phi Beta Kappa scholar is apt to be far more varied in his training than he was formerly. In other words Mahomet has not gone far toward the mountains, but the mountains are coming to Mahomet. Professor Thorndike deplores this lack of high-

grade scholars in the medical profession, and hopes for better things in the future. But I have little sympathy with either his hopes or his desires.

In his analysis of the careers which these scholars have followed in the past sixty years, Professor Thorndike makes no mention of the profession of engineering. It is to be inferred that there have been no Phi Beta Kappa scholars who have become engineers, or at least that the number is so small as to be negligible. The fact is startling, as it also is pregnant with meaning. Has the educational concept of scholarship been such that two of the chief learned professions have been almost excluded therefrom? Or would it be more reasonable to suppose that the Phi Beta Kappa, like the Sigma Xi, is really a broad society of specialists? The reason so few Phi Beta Kappas have chosen the engineering profession is not difficult to understand. It has happened that the education of engineers has for years been more nearly in line with modern educational progress than that of any other of the learned professions. It really has been the one profession in America which has served as a model for all others in education, a model toward which all others are rapidly approaching. The profession early recognized the fact, possibly because it was not dignified with the appellation of learned, and did not, therefore, see the need of the so-called learned culture, that the most successful results must come, without neglecting other useful and cultural studies, from an early, consistent and rational specialization. Can any one believe that the profession would stand where it does to-day, richly meriting the title of learned, that it would have accomplished the tremendous results it has, had it followed the methods so long in vogue in the medical and legal professions, the adding of a year or two of purely didactic professional instruction upon any sort of a foundation? Because the engineering profession stood so far in advance of all other professions in its systems of education seventeen years ago, and because Phi Beta Kappa would not admit that any other system than its own could produce scholars, we have to-day the Society of the Sigma Xi, now firmly established in nearly all of our best universities. The medical profession tried too long and tried in vain to polish off the general scholar or the no scholar into the special scholar. But it is recognizing its error, recognizing that the best success means not so much more years of study as an earlier and rational specialization.

It is a fact, pretty well recognized by the science teacher, that the average college graduate, who has had no special scientific training, has no advantage in the laboratory over the average graduate of the high school. The latter has not so much to forget and he has not forgotten so much, his youthful plasticity is less impaired, his observational powers less dulled. Indeed, I have no hesitation in saying, and in saying it I draw from many years' experience, that a four years' college course in the languages, literature and mathematics is of positive injury to the modern student of medicine. He has lost valuable years, even as the musician has lost them who begins his special studies at twenty-two or twenty-three years of age, lost them irrecoverably. Such a student might make the good family doctor, whose loss Dr. Draper deplores, but the chances for the highest success in his profession have been impaired.

In some of the better medical colleges the course of the would-be physician is now marked out with more or less precision through six years from the high school to the hospital, and it needs no prophet to say that what these schools are

doing will soon be the rule in medical education. And not only will the course from the high school to the doctor of medicine degree be a fixed one, with only such variations as may lead to diverse ends in the profession, but I believe that the course will reach back into the high school, even as the engineering course already does to some extent. Furthermore, not only will such methods be accepted as most fitting in these professions, but similar methods will eventually become the rule for all the more important professions and vocations in life. Is there not, then, a grain of reason in the protest of the business man that the college education does not prepare for business life? How, too, can Professor Thorndike expect to see any material increase in the proportion of Phi Beta Kappa scholars in such professions unless the mountains come quite to Mahomet by the admission that the professional scholar may be the equal of the cultural scholar?

I would not for a moment have it inferred that I have aught to say in deprecation of that general cultural education of which Phi Beta Kappa has been for so long the honored exponent, but I do say that such an education is in large part a special education, and not to be desired for all men. Though such men as Professor Peck may still continue to assert that the graduate of the liberal arts course is a 'gentleman and scholar,' while the scientific man is only a 'sublimated tinker,' the world in general is ceasing to look upon the scientist as being only half educated, and the sooner the last vestige of such pedantry has disappeared the better it will be for American higher education.

I do insist that for either the literary or the scientific student the education should widen his sympathies and broaden his outlook. A few cranks may be endured, but a world of cranks would be a dreary place to live in. But one may have broad sympathies without being a jack of all trades, and the intermingling of many men of many minds does more to teach us tolerance than all the book education that can be compressed into the cranium of the pedant. The best remedy for intolerance is the habit of thinking accurately.

I urge only that every lad or every lass should be early guided into the pathway along which his future lies, that he should have a motive for all he does. A motive, indeed, is more important than much knowledge, for it brings zeal, ambition and earnestness, so often, so deplorably often, lacking in the college undergraduate. Indeed, I care less for the kind of a preparation a student has if he clearly knows what he wants—he will remedy his faults in the course of time. As college men I firmly believe that we are too careful as to the kind and amount of preparation a student has when he enters college and too careless of the work he does while in college. Some of the best and most successful students I have ever known have been those whom the college rules would have excluded, while many a one who fulfills all technical requirements is a dismal failure.

It was but six years ago that President Dwight of Yale University said: 'In any future development of the college system, the chief purpose of general culture should not give way or be subordinated to any purpose of special culture, with a view of some special work in future years.' It has been but a few weeks since the educational world has been startled by the announcement that Greek would no longer be required of the Bachelor of Arts graduate of Yale. Nor is this all. Whereas to-day Yale College requires eight or ten years' study of the ancient languages as a prerequisite for the B.A. degree, next year it will require not more than four, and none of them in the college. Such con-

cessions, coming from so conservative an institution as is Yale, are of the deepest significance. They mean that the movement toward special education can not be ignored by any institution. The demand for special education is imperative. Like the trusts, it has come to stay.

It is reported that this change in the Yale requirements was opposed by the language teachers of the faculty, who deplored the debasement of the time-honored degree of Bachelor of Arts. In many of our larger universities, as well as smaller ones, three baccalaureate degrees are given in the school of liberal arts—Bachelor of Arts, Bachelor of Philosophy and Bachelor of Science. If one will examine the lists of graduates of such institutions he will be struck with the proportionally greater frequency with which the Bachelor of Science degree is given in recent years. Usually the graduates receiving this degree outnumber those receiving both of the other degrees. In fact one can only be surprised at the rapid diminution in the number of those striving for the old simon-pure badge of a liberal culture. Indeed, those who seek the indeterminate, betwixt and between, hybrid degree of Bachelor of Philosophy are never very numerous. I dare venture the assertion that any college which persists in the old cultural course of thirty years ago to the exclusion of others, will soon be teaching empty benches for the most part. A few institutions like the University of Michigan, the University of Minnesota and Leland Stanford have abandoned the Bachelor of Philosophy and Bachelor of Science degrees, giving to all alike in the non-professional courses the one degree of Bachelor of Arts.

To those who believe with me that an earlier specialization or an earlier motive in education is to be desired, such continued rending of the bonds of liberal culture offers much of encouragement, though only the outcome of methods long ago introduced by Harvard University, the system of electives or optionals.

No one can doubt now but that this system has been of benefit. It permitted for the first time the student who was not content with an elementary training, to widen to some extent his preparation for special pursuits in life. So grudgingly bestowed at first upon the senior, it has now become the privilege of the freshman. But I can not believe that the optional system has been altogether a blessing. It has done much to encourage the ambitious, but it has also done much to stultify the lazy. We all know how many students there are who seek a degree rather than an education. And many of us also know that the average non-professional college student can not be favorably compared with the professional student of like age for zeal and ambition. There is too often a tendency for a college teacher to be lax in discipline, that he may not diminish the attendance upon his classes. The student's choice is far too often decided by trivial circumstances—the advice of a classmate, the reputation of a teacher, the ease of certain studies, or often indeed by the toss of a penny. It is only the minority who deliberately plan their work, because it is only the minority who know what they desire to do in life, and it is seldom that the student gets advice from those whose duty it should be to advise him. But the optional system is resolving itself as rapidly as circumstances permit into special courses, either recommended or required, and the student who now goes through the senior year without some notion of what he is striving after is becoming less and less frequent.

It was but a short time ago that President Butler of Columbia University shocked the world of higher education by suggesting that the college course should

terminate with the sophomore year, that the junior and senior years should be distinctively years of professional education, as in reality they are becoming in most of the better universities of the United States. He would have it that every student should orient himself, should decide what he expects to do in life by the beginning of his junior year.

On the other hand, it seems also apparent that the freshman and sophomore years are gradually being eliminated from the college and relegated to the so-called schools of secondary education. There are many high schools which would willingly, and could with advantage, take over the work of the first one or two years of the college. The average college instructors of the first and second years do not compare over favorably with those in the upper classes of the high schools, and the cost of instruction is not much greater. By thus distributing the work of these two years in many more institutions a far greater number of young men and women would receive the benefits of higher education. We all know how much the propinquity of the college has to do in influencing the average high school graduate. Every college town sends a much larger proportion of its youth to college than do towns less favorably situated. I doubt not that if the universities of our country, and especially the state universities, should encourage such an extension of the high-school course we soon would have students entering the junior year from nearly every city of fifteen or twenty thousand inhabitants, and that too in larger number than now complete the sophomore year in our colleges. And I have no doubt, were President Butler's suggestion to become a reality, that hundreds of our high schools would soon become colleges, colleges moreover that would do better work than does the average college of the present time.

Moreover, I believe that such a plan is the only one which will preserve the bachelor degree from extinction. When it becomes the rule that the medical diploma is given only after a six years' course of work from the present high school graduation, who is there that will care for the bachelor degree midway? Twenty years hence there will be fewer bachelors of science or arts among medical graduates than there are at the present time, and not more than one in ten of our physicians now possess the degree. When the engineer is required to have the professional degree of C.E. or M.E. there will be very few students who will strive after the bachelor degree. In other words, it seems to me that the tendency of American higher education is toward the German system. When our high schools become Gymnasia and Realschulen our universities will begin where theirs do, at the beginning of the junior year.

At a recent meeting of college educators of prominence at Evanston the subject of the abridgment of the college course was discussed, with but little approbation. The literary student, the student of the so-called cultural courses, almost unanimously opposes any suggestion of the elimination of the college. Fortunately or unfortunately, however, college educators do not control college education, and he is a wise man who keeps closely in pace with the world. If the world demands that special education shall begin with the junior year or earlier, that the college shall end with the sophomore year, aught we may do or say will avail little; the controlling causes are social, not educational.

Within the past few years there has been an extraordinary increase, both relatively and absolutely, as regards men, in the attendance of women in the college and uni-

versity, as well as the high school. The cause, apparently unaffected by national conditions of prosperity or distress, has not been satisfactorily explained. Doubtless a partial explanation is that fewer vocations in life are open to woman and she, therefore, seeks that higher training afforded by the college of arts which will fit her for her more peculiar vocation, that of teaching in the secondary schools. On the other hand, it is equally certain that a larger proportion than ever before of young men are seeking professional and technical education, notwithstanding the greatly increased requirements.

By every teacher of wide experience in higher education certain fundamental differences in the mental characteristics of men and women students are, I think, acknowledged. Whether these differences are inherent or whether they are acquired is by no means certain, and does not concern us here. But that there are such differences, I believe every teacher of the natural sciences at least will admit.

The woman student is usually more faithful in attention to duty, she is less distracted by outside influences, less fitful and wayward in her work. That woman has greater fortitude than man in suffering and misfortune is universally acknowledged; the same trait is displayed in her greater conscientiousness in the performance of the routine duties of life. Her memory is better than, and her power of application as good as, are those faculties in man. As a result she averages better in all those college studies where memory and faithfulness are most conducive to excellence. In language, literature and recitative science work the larger proportion of the better students are women, where the sexes are equally divided in number. In the coeducational colleges, the proportion of women who attain the distinction of membership in Phi Beta Kappa is nearly three fifths of the whole, though those eligible for such distinction are scarcely more than those of the men. Moreover, the age of graduation of women from the college is distinctly less than that of men. Certain causes partly account for the undoubted superiority of women in the general college course, though not wholly. There are decidedly more girls than boys who graduate from the high school, and as fewer girls than boys take up college work, there is a larger selection of the more able and serious women. Family ambitions, and the mistaken idea that it is the proper social thing, send many a worthless young man to college, while most women who go do so because of some serious purpose. Furthermore, as every physiologist knows, women reach maturity earlier than do men. A girl of eighteen has the intellectual maturity of the boy of twenty.

That all women students do not excel, of course goes without saying. Indeed, the frivolous girl, she who goes to college chiefly for the social or sorority advantages she hopes to find there, is usually quite as worthless, from an educational point of view, as the young man whose chief aim is a good time or athletics. I really think that we may truthfully say of the woman student that 'When she is good, she is very good; but when she is bad, she is horrid.'

On the other hand, the woman student in the science laboratory is a comparative failure. She has less inventiveness and originality, less independence and self-reliance; she invariably needs more assistance and guidance. In the concrete, observational sciences, she is less able to draw conclusions. In other words, she is deficient in research ability, save perhaps in abstract mathematics. On the other hand, opportunities for women in scientific research are probably even greater than they are for young men; the bright scientific woman is really more certain of a

remunerative pedagogical position in many branches than is her equally apt brother.

One result of these sexual characteristics is that women more often cling to the older courses in the humanities, the so-called cultural courses. She prefers these studies, not only because there is less opportunity for her in the technical professions, not only because her more usual ambition is to follow that noblest of all vocations, that of the home-maker, but because her tastes and proclivities fit her better for the more esthetic and humanistic studies.

In the coeducational colleges the women now generally exceed the men in number. This slow relative increase of the men, or in some instances actual decrease, has often been attributed to coeducation, the dislike of young men to mingle with young women in the class-room, to be brought into competition with them where they are so often outshone. I doubt this very much. The milksop who resents the rivalry of women, who thinks himself so far superior to them that he is unwilling to be shown his mistake, ought to be tied to an apron string and smothered in his callowness. The real reason is that men are in greater numbers seeking that special training which they do not or can not get in the general college course, while women are seeking that special training which they do get in the humanities. Nor do I think that either are any more swayed by the commercial spirit which so many superficial observers deplore. There are many advantages in coeducation of the sexes, as well as certain disadvantages. The women need that stimulation in self-dependence and originality which the mingling of young men will surely give them, and the men need the greater esthetic cultivation, the broader humanizing outlook, which women fellow students will surely give them. Coeducational colleges will never become women's colleges so long as they offer anything which men want, and those courses of study which women prefer will always offer that which many, though not all, men will want.

Whatever may be the tendencies of modern higher education, whatever may be the outcome of the various movements now making, who is there that can repress the feeling of exultation and of congratulation in the great achievements, the lofty aims of our colleges and universities? Whether we are to become a nation of scholars or a nation of specialists, I know not, but that we shall become a greater nation, a wiser nation, a more prosperous nation because of the high school, the college and the university is certain.

S. W. Williston.
University of Chicago.

THE LIMITS OF SCIENCE.

In moving a vote of thanks a couple of months since, Lord Kelvin said that science positively affirmed creative power and that modern biologists were coming once more to a firm acceptance of a vital principle. These remarks have given rise to an interesting series of letters to the London *Times,* which we reproduce:

When a man of known distinction gives public expression to an opinion it is, of course, received with attention. But its validity will depend, not upon his distinction, but upon the authority which he has achieved in the field to which his opinion relates.

In the domain of physics, to the exploration of which Lord Kelvin has devoted an honored lifetime, he would be a bold man who would cross swords with him. But for dogmatic utterance on biological questions there is no reason to suppose that he is better equipped than any person of average intelligence.

In a recent speech Lord Kelvin has

taken occasion to define with more precision than, perhaps, he has ever done before his view of the possible attitude of scientific inquiry to inorganic nature on the one hand, and to organic on the other. And he has emphasized this in the letter published in your columns to-day.

That view is, as I apprehend, this: In the former, he claims for scientific investigation the utmost freedom; in the latter, scientific thought is 'compelled to accept the idea of creative power.' That transcends the possibilities of scientific investigation. Weismann defines this to be "the attempt to indicate the mechanism through which the phenomena of the world are brought about. When this mechanism ceases science is no longer possible." Lord Kelvin, in effect, wipes out by a stroke of the pen the whole position won for us by Darwin. And in so doing it can hardly be denied that his present position is inconsistent with the principle laid down in his British Association address at Edinburgh in 1871:

"Science is bound by the everlasting law of honor to face fearlessly every problem which can be fairly presented to it. If a probable solution, consistent with the ordinary course of nature, can be found, we must not invoke an abnormal act of creative power." Among the biologists of the present day I apprehend that there are few who are prepared to contend that the Darwinian theory is not so consistent.

It is a common dialectic artifice to state an opponent's position in terms which allow of its being more readily confuted. It is scarcely, however, worthy of Lord Kelvin. What biologist has ever suggested that a fortuitous concourse of atoms 'could make * * * a sprig of moss'? I confess I think that Lord Kelvin's first thoughts were best, and that it is equally absurd to suppose that a crystal could be made in the same way. A fortuitous concourse of atoms might produce an amorphous mass of matter; but to form a crystal the 'atoms' must be selected and of the same kind, and their concourse is, therefore, not fortuitous. The fact is that the argument from design applies, for what it is worth, as much to a diamond as to a caterpillar. If it is to be rejected in favor of a mechanical explanation in the one case, it is impossible, logically, to maintain it in the other.

Lord Kelvin quotes Liebig as denying that 'grass and flowers * * * grew by mere chemical forces.' If not, it may be asked, by what do they grow? If growth is to be accounted for by a 'vital principle,' this must be capable of quantitative measurement like any other force. If it is physical energy in another form, Liebig's dictum is futile. If not, organisms are not subject to the principle of conservation of energy. Yet this principle was first indicated by Mayer, a biologist.

Physicists, it may be remarked, are not without their own difficulties. But we do not dismiss their conclusions impatiently on that account. Lord Kelvin said that 'ether was absolutely non-atomic; it was absolutely structureless and homogeneous.' He speaks of it as if it were a definite concrete thing like the atmosphere. But we can not picture to our minds how such a medium can possess elasticity, or how it can transmit undulations. The fact is that the ether is a mere mathematical figment, convenient because it satisfies various formulæ. As it is only an intellectual conception, we may invest it with any properties we please. The late Professor Clifford once told me that it was harder than steel. I believe it is now thought to be gelatinous. Anyhow, it is nothing more than a working hypothesis, which some day, like phlogiston, will only have historic interest.

W. T. Thiselton-Dyer.

Kew, May 4, 1903.

Many men of science will heartily sympathize with Sir W. T. Thiselton-Dyer's protest against the attack on the Darwinian theory of evolution recently delivered at the University College. But it seems to many of us somewhat astonishing that an institution which professes to stand in the vanguard of scientific work in London, and which possesses its accredited teachers in biology, should open its doors to irresponsible lecturers on 'directivity,' even if they are supported by the doyens of physical science. To these public lectures condemning Darwinism men and women students from all London colleges are invited, and the president of the college congratulates the assembly on the proceedings of the day. I have always understood that the college was absolutely non-sectarian in character, and that religious controversy and theological propagandism were not admitted within its walls. To the founders of the college, Grote, Bentham, Hume, it would have been a painful revelation to find the truth or falsehood of any scientific hypothesis questioned within its walls from the standpoint of theological polemics. I think there is small doubt that the wishes of these founders, that science and scholarship should be treated apart from theological opinions, have been rigorously carried out in the teaching of the many distinguished men who have held chairs in the college. This non-theological attitude has attracted to the college many of our fellow subjects of Buddhist, Mahomedan and Jewish faiths. But will they find the college the same free ground if they see its authorities recognizing a public course of lectures on 'Christian Apologetics'? A faculty of theology making a scholarly study of dogmatics has a totally different footing from an irresponsible association providing a controversial treatment of the basis of modern biological science. The attack is not delivered openly in the organs where scientific men criticize the foundations of their knowledge, but covertly, with the tacit assumption that the truth in question is hostile to the Christian belief. It can not be too often reiterated that the theory of natural selection has nothing whatever to do with Christianity. Many good Christians accept it on the scientific evidence; many agnostics reject Christianity without being biased by any theory of evolution. If Lord Kelvin wishes to attack Darwinism, let him leave the field of emotional theological belief and descend into the plane where straightforward biological argument meets like argument. Let him examine the facts of heredity, of variation, and of selection, and offer controverting facts. A dozen biological journals would be open to receive his criticisms and meet them with courteous rejoinder. In this way he would be adding to his already immense services to science; he does not forward knowledge when he adds the weight of his name to an anti-Darwinian crusade which does not proceed from the inspiration of science, but from a mistaken notion that man can *a priori* assert what method of conducting the universe is or is not consonant with the Divine dignity.

Karl Pearson.

Hampstead, May 7, 1903.

I feel compelled as a physiologist to express my regret that a most distinguished British botanist has thought it necessary to 'cross swords' with the most distinguished of British physicists with reference to a question on which it is desirable that all men of science should be in accord. I shall not inquire whether the views expressed by the director of Kew Gardens in his letter which appeared on May 7 are entertained by biologists generally. My object is to disclaim on the part of my own science, that of physiology, any participation in the opinion that, for the dis-

cussion of biological questions, Lord Kelvin is 'no better equipped than any person of average intelligence.'

The question at issue is how far 'mechanical explanations' can be given of the phenomena of life. The view which for the last half century has been taught by physiologists may be stated as follows: All the processes observed in living organisms are of such kind as to admit of being investigated by the same methods as are used in the investigation of the phenomena of non-living nature—*i. e.*, by measurement of their time and place relations under varying conditions—in other words, by the method of experiment. But, beyond the limit thus stated, we have to do with processes which can not be directly measured or observed. These are, first, the mental processes, whether of man or of animals, in respect of which the experimental psychologist is unable to go beyond the estimation of conditions and effects; and, secondly, the processes of organic evolution by which the organism grows from small beginnings to such form and structure as best fit it for its place in nature. This is the doctrine which was professed by Helmholtz, the founder of modern physiology, as the result of those early investigations which were embodied in his well-known treatise on the 'Erhaltung der Kraft,' in which he demonstrated more clearly than had been done before that the natural laws which had been established in the inorganic world govern no less absolutely the processes of animal and plant life, thus giving the death-blow to the previously prevalent vitalistic doctrine that these operations of life are dominated by laws which are special to themselves. He thereby brought into one the before too widely separated sciences of physiology and physics.

It was not until Helmholtz had been engaged for some eight years in building up the new science of physical physiology that the German physiologist and the English physicist (W. Thomson) came into personal relation with each other at Kreuznach. In one of Helmholtz's letters to his wife he tells of Thomson's 'surpassing acuteness, clearness and versatility,' qualities which impressed him so much that in their intercourse he found himself to be by comparison 'a dullard.' He was evidently wrong. From the botanical point of view, the future Lord Kelvin was no better than 'a person of average intelligence.' But, in all seriousness, it is surely a mistake to suppose that biological problems appeal so little to the intellect that, unless he is an expert, a man of transcendent ability is incapable of dealing with them.

J. BURDON-SANDERSON.

OXFORD, May 9, 1903.

I am quite impenitent at the irrelevant rebuke of the Oxford Regius Professor of Medicine. But he might represent what I wrote with more precision. I did not express so absurd an opinion as that Lord Kelvin "was no better than 'a person of average intelligence.'" Nor do we need in this country a testimonial from Helmholtz to the contrary. What I wrote was: 'For dogmatic utterance on biological questions there is no reason to suppose that he is better equipped than any person of average intelligence.' By 'equipped' I intended that he is not prepared by technical study of the problems on which he pronounces judgment.

Sir J. Burdon-Sanderson concludes by saying: 'It is surely a mistake to suppose that biological problems appeal so little to the intellect that, unless he is an expert, a man of transcendent ability is incapable of dealing with them.' The first clause of this sentence is obviously absurd; the latter is a simple fact. Any one who has taken the trouble to read the admirable volumes

of Darwin's correspondence recently published will easily inform himself that a trained master mind may devote a lifetime to biological problems and yet feel some hesitation in pronouncing decisive judgment upon them. An untrained master mind may hesitate still more. The late Lord John Russell was credited with the capability at a moment's notice of performing the operation for stone or taking command of the Channel fleet. But such versatility is believed to be rare. 'Transcendent ability' will not enable a man without previous training to either paint an Academy picture or read the Hebrew Bible.

In his speech at University College Lord Kelvin is reported to have said: 'Modern biologists were coming once more to a firm acceptance of something, and that was a vital principle.' I deny the fact. And Sir J. Burdon-Sanderson credits Helmholtz with having given 'the death-blow to the previously prevalent vitalistic doctrine that these operations of life are dominated by laws which are special to themselves.' He explains 'these operations' to mean 'the processes of animal and plant life.' Perhaps he will tell us how he reconciles this position with that of Lord Kelvin, on the one hand, and that attributed by Lord Kelvin to Liebig, on the other. The new 'vital principle' is only a resurrection of the old 'vitalistic doctrine.'

One word more. Sir J. Burdon-Sanderson cites Helmholtz for the statement that 'the processes of organic evolution * * * can not be directly measured or observed.' If he will consult recent volumes of the Philosophical *Transactions* or the pages of 'Biometrika' I think he will find reason, in the light of recent research, to disagree with him.

W. T. Thiselton-Dyer.

Kew, May 11, 1903.

Tastes differ, of course; but if I were in Lord Kelvin's place I would rather be criticized by Sir William Thiselton-Dyer than defended by Sir John Burdon-Sanderson. His letter in your issue of to-day is in three paragraphs. The first is sugar, the second aloes, and the third sugar again. This sort of sandwich is popular in the nursery; I fancy a man would sooner have his dose undisguised.

After vindicating Lord Kelvin's right to speak with exceptional authority upon a subject widely separated from those to which he has devoted a long and strenuous life, Sir John Burdon-Sanderson goes on to show that he is entirely wrong. Lord Kelvin drew a sharp line across nature, and said that biologists are now engaged in searching for the 'vital principle' which alone can explain the facts of living matter. His mentor asserts the continuity of nature; affirms that the processes applicable on one side of Lord Kelvin's line are equally applicable on the other; and declares it to be the glory of Helmholtz that he demonstrated more clearly than had ever been done before that "the natural laws which had been established in the inorganic world govern no less absolutely the processes of animal and plant life, thus giving the death-blow to the previously prevalent vitalistic doctrine." He does no doubt add that some things, such as mental phenomena in men and animals, are not yet susceptible of explanation; but the same holds good, as Lord Kelvin would be the first to admit, about some of the most important phenomena of non-living matter.

When men of authority thus flatly contradict one another on fundamental questions, it is very hard for the humble inquirer to know what to believe. It becomes all the harder when neither the physicists nor the physiologists can agree among themselves. Sir John Burdon-

Sanderson is evidently not at one with Sir William Thiselton-Dyer, though he reluctantly supports the main contention of the latter. Lord Kelvin says that the ether is absolutely non-atomic, absolutely structureless, and homogeneous. Professor Osborne Reynolds announced not long ago, as the result of the latest investigations, that the ether is atomic or molecular in structure, gave the size of the molecules, calculated their mean free path, and told us that the ether is 500 times as dense as gold, that its mean pressure is 750,000 tons to the square inch, and so forth.

'Whom shall my soul believe?' is the question of the poet, which is echoed by

Your obedient servant,

QUE SÇAIS-JE?

LONDON, May 11, 1903.

I suppose I ought to bow my neck to the rod now that it is wielded judicially by the editor of the *Times*. I feel no inclination to do so. Nevertheless, I hope I may be permitted to point out that 'directive power' is, as a matter of fact, 'the stroke of the pen' by which 'Lord Kelvin, in effect, wipes out * * * the whole position won for us by Darwin.'

It is no use mincing matters. Students of the Darwinian theory must be permitted to know the strength and weakness of their dialectic position. What that theory did was to complete a mechanical theory of the universe by including in it the organic world.

The attempt to introduce a directive force into the Darwinian theory is no new thing. It is, of course, only creative power in disguise. The most notable are those of Nägeli in Germany, and Asa Gray and Cope in America. Weismann has generalized them as an attempt to set up a 'phyletic vital force,' and he points out that if we accept anything of the kind 'we should at once cut ourselves off from all possible mechanical explanation of organic nature.'

I can hardly suppose that Lord Kelvin was not perfectly aware of this.

May I further add that the 'world of spirit to which the world of matter is altogether subordinate,' to which Dr. Alfred Wallace would introduce us, is not, so far as I know, a subject which biologists find themselves in a position to investigate? The 'ether' seems sufficiently perplexing.

W. T. THISELTON-DYER.

KEW, May 13, 1903.

It seems to me that, were the discussion excited by Lord Kelvin's statements to the Christian Association at University College allowed to close in its present phase, the public would be misled and injustice done to both Lord Kelvin and his critics. I therefore beg you to allow me to point out what appear to me to be the significant features of the matter under discussion.

Lord Kelvin, whose eminence as a physicist gives a special interest to his opinion upon any subject, made at University College, or in his subsequent letter to you, the following statements:

1. That 'fortuitous concourse of atoms' is not an inappropriate description of the formation of a crystal.

2. That 'fortuitous concourse of atoms' is utterly absurd in respect to the coming into existence, or the growth, or the continuation of the molecular combinations presented in the bodies of living things.

3. That, though inorganic phenomena do not do so, yet the phenomena of such living things as a sprig of moss, a microbe, a living animal—looked at and considered as matters of scientific investigation—compel us to conclude that there is scientific reason for believing in the existence of a creative and directive power.

4. That modern biologists are coming once more to a firm acceptance of something, and that is—a vital principle.

In your article on the discussion which has followed these statements you declare that this (the opinions I have quoted above) is 'a momentous conclusion,' and that it is a vital point in the relation of science to religion.

I do not agree with that view of the matter, although I find Lord Kelvin's statements full of interest. So far as I have been able to ascertain, after many years in which these matters have engaged my attention, there is no relation, in the sense of a connection or influence, between science and religion. There is, it is true, often an antagonistic relation between exponents of science and exponents of religion when the latter illegitimately misrepresent or deny the conclusions of scientific research or try to prevent its being carried on, or, again, when the former presume, by magnifying the extremely limited conclusions of science, to deal in a destructive spirit with the very existence of those beliefs and hopes which are called 'religion.' Setting aside such excusable and purely personal collisions between rival claimants for authority and power, it appears to me that science proceeds on its path without any contact with religion, and that religion has not, in its essential qualities, anything to hope for, or to fear, from science.

The whole order of nature, including living and lifeless matter—man, animal and gas—is a network of mechanism the main features and many details of which have been made more or less obvious to the wondering intelligence of mankind by the labor and ingenuity of scientific investigators. But no sane man has ever pretended, since science became a definite body of doctrine, that we know, or ever can hope to know or conceive of the possibility of knowing, whence this mechanism has come, why it is there, whither it is going, and what there may or may not be beyond and beside it which our senses are incapable of appreciating. These things are not 'explained' by science, and never can be.

Lord Kelvin speaks of a 'fortuitous concourse of atoms,' but I must confess that I am quite unable to apprehend what he means by that phrase in the connection in which he uses it. It seems to me impossible that by 'fortuitous' he can mean something which is not determined by natural cause and therefore is not part of the order of nature. When an ordinary man speaks of a concourse having arisen 'by chance' or 'fortuitously,' he means merely that the determining conditions which have led by natural causation to its occurrence were not known to him beforehand; he does not mean to assert that it has arisen without the operation of such determining conditions; and I am quite unable to understand how it can be maintained that 'the concourse of atoms' forming a crystal, or even a lump of mud, is in any philosophic sense more correctly described as 'fortuitous' than is the concourse of atoms which has given rise to a sprig of moss or an animal. It would be a matter of real interest to many of your readers if Lord Kelvin would explain more precisely what he means by the distinction which he has, somewhat dogmatically, laid down between the formation of a crystal as 'fortuitous' and the formation of an organism as due to 'creative and directive purpose.'

I am not misrepresenting what Lord Kelvin has said on this subject when I say that he seems to have formed the conception of a creator who first of all, without care or foresight, has produced what we call 'matter,' with its necessary properties, and allowed it to aggregate and crystallize as a painter might allow his pigments to run and intermingle on his palette; and then, as a second effort, has

brought some of these elements together with 'creative and directive purpose,' mixing them, as it were, with 'a vital principle' so as to form living things, just as the painter might pick out certain colors from his confused palette and paint a picture.

This conception of the intermittent action of creative power and purpose does not, I confess, commend itself to me. That, however, is not so surprising as that it should be thought that this curious conception of the action of creative power is of value to religion. Whether the intermittent theory is a true or an erroneous conception seems to me to have nothing to do with 'religion' in the large sense of that word so often misused. It seems to me to be a kind of mythology, and, I should have thought, could be of no special assistance to teachers of Christianity. Such theories of divided creative operations are traceable historically to polytheism.

Lastly, with reference to Lord Kelvin's statement that "modern biologists are coming once more to a firm acceptance of something—and that is 'a vital principle.'" I will not venture to doubt that Lord Kelvin has such persons among his acquaintance. On the other hand, I feel some confidence in stating that a more extensive acquaintance with modern biologists would have led Lord Kelvin to perceive that those whom he cites are but a trifling percentage of the whole. I do not myself know of any one of admitted leadership among modern biologists who is showing signs of 'coming to a belief in the existence of a vital principle.'

Biologists were, not many years ago, so terribly hampered by these hypothetical entities—'vitality,' 'vital spirits,' 'anima animans,' 'archetypes,' 'vis medicatrix,' 'providential artifice,' and others which I can not now enumerate—that they are very shy of setting any of them up again. Physicists, on the other hand, seem to have got on very well with their problematic entities, their 'atoms' and 'ether,' and 'the sorting demon of Maxwell.' Hence, perhaps, Lord Kelvin offers to us, with a light heart, the hypothesis of 'a vital principle' to smooth over some of our admitted difficulties. On the other hand, we biologists, knowing the paralyzing influence of such hypotheses in the past, are as unwilling to have anything to do with 'a vital principle,' even though Lord Kelvin erroneously thinks we are coming to it, as we are to accept other strange 'entities' pressed upon us by other physicists of a modern and singularly adventurous type. Modern biologists (I am glad to be able to affirm) do not accept the hypothesis of 'telepathy' advocated by Sir Oliver Lodge, nor that of the intrusions of disembodied spirits pressed upon them by others of the same school.

We biologists take no stock in these mysterious entities. We think it a more hopeful method to be patient and to seek by observation of, and experiment with, the phenomena of growth and development to trace the evolution of life and of living things without the facile and sterile hypothesis of 'a vital principle.' Similarly, we seek by the study of cerebral disease to trace the genesis of the phenomena which are supposed by some physicists who have strayed into biological fields to justify them in announcing the 'discovery' of 'telepathy' and a belief in ghosts.

Yours faithfully,

E. RAY LANKESTER.

LONDON, May 15, 1903.

I felt sure that I could not keep out of this interesting correspondence much longer, but I will try to be brief; and in congratulating Professor Ray Lankester on his admirable letter I should like to explain that the adjective 'fortuitous' as employed

by Lord Kelvin was evidently not selected by him as specially appropriate or illuminating, but merely used as part of a well-known phrase or quotation. It is clear that what our chief meant was that the formation of a crystal, and such like, proceeded in accordance with the unsupplemented laws of ordinary mechanics; whereas the formation of an animal or plant seemed controlled by something additional —viz., the presence of a guiding principle or life-germ, the nature of which neither I nor any other physicist in the least understands. I shall be surprised if biologists claim that they really understand it either.

It is true that Lord Kelvin employed the popular phrase 'creative power'—a phrase I should not myself use, because I am unable to define it—and in other respects his wording was more appropriate to a speech than to a philosophic essay, but nevertheless his speech as reported had all the usual subjective interest attaching to the freely-spoken personal convictions of a great man, attained as the outcome of a lifelong study of various aspects of nature.

As to the little parting shot at me about 'telepathy,' it is true that I regard it as a recently discovered fact, opening a new and obscure chapter in science; it is also true that Lord Kelvin, Professor Ray Lankester and nearly all biologists disagree contemptuously with this opinion. Well, we shall see. *Die Zeit ist unendlich lang.*

Yours faithfully,

Oliver Lodge.

The University of Birmingham,
May 19, 1903.

SCIENTIFIC BOOKS.

Reports of the Princeton University Expeditions to Patagonia, 1896–1899; I.—Narrative and Geography. By J. B. Hatcher. Princeton, The University. 1903. 4to. Pp. xvi + 314; plates and map.

From the rather meager remains of vertebrates collected on the renowned voyage of the *Beagle* and turned over to Richard Owen by Darwin for study, paleontologists were first made aware of what has proved to be practically a new world of animal life which, though for the most part now extinct, was, within times geologically recent, extremely rich.

The novelty and wealth of this extinct fauna were fairly indicated by the discoveries of Fitzroy and Darwin, but the interest then aroused went little further until about 1887, when Señor Carlos Ameghino accompanied an expedition to southern Patagonia and began that series of discoveries which has since made him, and his brother Florentino, famous. The new world brought to light by them was totally unlike anything previously known among vertebrate faunas either living or fossil, and aroused the interest of paleontologists, geologists and zoologists everywhere.

Incidentally to the work of describing and classifying these remarkable remains certain hypotheses were advanced by the brothers Ameghino which concerned the relations of these fossil animals to those of the northern hemisphere, and the age assigned to the strata in which the fossils were found. These hypotheses were not generally accepted, and for some time it has been regarded as most desirable that an examination of the geology should be made by experts trained in other fields. This it was thought would harmonize the conditions revealed by observation in Patagonia with the results of expert work elsewhere, and clear up the confusion which seemed to have arisen in regard to the age and succession of the Patagonian strata.

It was for this purpose that Mr. Hatcher organized and carried out the explorations described in this volume, while he was curator of vertebrate paleontology for the university. Their primary object was to make observations and collections bearing on the geology and paleontology of the region, while such attention as circumstances allowed was from time to time directed to other branches of natural history. The cordial and effective cooperation of Professor W. B. Scott, head of the department of geology and paleontology,

was accorded to Mr. Hatcher, and substantial financial aid was extended by friends and alumni of the university. The publication of the results in the sumptuous and elegant form in which they appear is made possible through the generosity of Mr. J. Pierpont Morgan; while acknowledgments are also due to South American officials, as well as to Dr. Florentino Ameghino and other naturalists of the region under consideration.

From March, 1896, to July, 1897, and from December, 1898, to September, 1899, Mr. Hatcher was in the field assisted by Mr. O. A. Peterson, and during the year following November, 1897, by Mr. A. E. Colburn. Much of the work was done on horseback, with a light wagon for transporting supplies and collections. The character of the Patagonian plains is such as rendered this method practicable even if frequently difficult. About half the total area of the region consists of vast terraced plains intersected by river cañons and of a subarid character, which, in the central portion, have been overflowed by lava beds covering hundreds of square miles. To the westward, out of a very mountainous region, rises the Andean range, cut here and there by rivers which rise in lakes on its eastern side.

At the base of the Andean mountains the Patagonian plains have an altitude of 3,000 feet, and slope very gently to the eastward. About fifty miles from the Atlantic coast they descend more rapidly by a series of terraces or escarpments which face to the eastward. The lowest of these has an average altitude of 350 feet and terminates in abrupt cliffs which, for a thousand miles, constitute the margin of the land, except for a narrow beach at the base, which, at high water, is covered by the sea or drenched with the spray of a perpetual and tremendous surf.

Scanty grasses with stunted shrubbery in occasional patches are characteristic of these vast and silent stretches, redolent of a loneliness which grips the imagination.

In the narrow cañons, or by the rivers in broad valleys of erosion, the traveler may come upon green spaces where the vegetation breaks into a joyous luxuriance, where birds abound, and deer and other animals meet man with fearless curiosity. Here the eye may search in vain for a limit to a basaltic desert extending in flat and stern monotony for leagues beyond the visible horizon. There some broad salt pan with deceptive mirage mimics the prehistoric lake of which it forms the dregs. At times wrapped in gloomy fogs or swept by tempests of incredible violence; fronting the towering Atlantic surges with unshaken cliffs and serrate talus, looking out to shifting bars of sand, the terror of the navigator; a vast cemetery for ghostly herds upon the like of which alive no man has ever gazed; it is a strange, silent, bitter, lonely land.

How our author went out into it, what he met, and how he fared, are told in modest yet most interesting fashion in this stately quarto. His story is so interesting and the unpretentious courage of the narrator so evident, the spirit of the land and its mysterious fascination so fully expressed, that few will close the book without a regret that it can not reach a wider audience. It is really too good to be reserved for the readers of quartos.

The volume is so full of scientific meat that it is difficult to make a satisfactory abstract, and impossible to condense it within the limits of such a review as this. There is something for every taste. The life of bird and beast; the phases and contrasts of vegetation; the life of the Tehuelche Indians and the waifs who have cast civilization aside like a garment, at the call of the wild; the topography and geology; and mingled with it all a flavor of real North American character to which something in each reader's soul will leap with sympathy and admiration.

It is pleasant to add that the adventurous undertaking proved a success, and its hardy leader may be congratulated, not only on the accomplishment of his project, the clearing up of geologic doubt and the gathering of long-buried scientific treasure, but also on the way he has told the story and the attractive manner in which it is illustrated and published.

W. H. Dall.

SCIENTIFIC JOURNALS AND ARTICLES.

The June number of the *Botanical Gazette* contains a monograph of the genus '*Cratægus* in northeastern Illinois,' by Professor C. S. Sargent. In it are described nineteen new species of *Cratægus*. The monograph is based chiefly upon the very thorough and extended collections of the *Cratægi* in this region by the Rev. E. J. Hill. Professor F. L. Stevens and Mrs. Stevens discuss the 'Mitosis of the primary nucleus of *Synchytrium decipiens*.' The process is of peculiar interest because of the exceptionally large size of the nucleus, its peculiarly rapid growth and its subsequent division. Dangeard and Rosén have declared the division of the primary nucleus in another species to be direct. The principal point of the present paper is to show that in the species studied by the authors the division is not direct, but mitotic. The authors hope that a fuller knowledge of the cytological peculiarities of the Chytridiales will lead to a more satisfactory knowledge of their nature and relationships. Professor J. Y. Bergen concludes his account of 'The macchie of the Neapolitan coast region,' in which he discusses particularly the adaptation of the plants constituting these xerophytic formations to their environment. An extended bibliography will be of particular service to ecological students of the Mediterranean region. Mr. Fred K. Butters describes and illustrates a new species of *Tuber, T. Lyoni*, discovered by Harold L. Lyon near Minneapolis, Minnesota. The fungi were collected in mature condition in the early spring, shortly after the melting of the snow and thawing of the soil. Mr. F. A. F. C. Went, of the University of Utrecht, announces the opening of a new botanical research laboratory in the tropics at Paramaribo. This laboratory will contain a room of adequate size where foreign naturalists will have opportunity for research work. Four new species of *Cratægus* and one of *Amelanchier* are described by Mr. W. W. Ashe, of Raleigh, N. C. Reviews of new books and current literature complete the number.

SOCIETIES AND ACADEMIES.

ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

The closing meeting of the season was held May 26. The president spoke of a theory recently advanced that man could draw before he could speak, and characterized the thought as very naive. The secretary communicated an account of the recent finding of the tomb of Thothmes IV. at Thebes. The paper of the evening by Dr. J. Walter Fewkes on 'Antiquities of Santo Domingo' gave an account of a visit to that island for the purpose of securing archeological specimens for the U. S. National Museum. Doctor Fewkes exhibited on the screen early and recent maps of the island, views of the city of Santo Domingo, its churches, markets, statues, etc., and gave many bits of interesting history connected with them. A number of views of the remarkable stone implements, pottery and wood carving found on the island were thrown on the screen. These consist of carved pestles, axes, etc., bowls of pottery with modeled ornamentation, carved seats, clubs, idols, etc., of wood. The caves of the island were described and Doctor Fewkes closed with a discussion of the state of our present knowledge of the Carib and Arawak invasion of the West Indies, and expressed a belief that these migrants were from South America, since the fauna and flora of the islands were strictly South American.

The discussion of the paper was participated in by Mr. McGuire, Doctor Fewkes, Professor McGee, Doctor Lamb and Doctor Baum. Doctor Fewkes' results will be published in a forthcoming number of the *American Anthropologist*.

Walter Hough,
Secretary.

DISCUSSION AND CORRESPONDENCE.

INDIAN POTTERY.

To the Editor of Science: Recently when coming down the Sevier River in Utah I found some fragments of coarse pottery about fifteen miles north of Panguitch. As I do not remember to have heard of pottery in that locality before, this find may be worth noting. The fragments were lying in sand

beside a sagebush near the traveled road. I could not stop for any careful examination at the time. I saw no indication of there ever having been a house, village or camp at the spot. The fragments are about one fourth inch thick and appear to be parts of two vessels, though they may belong to one. The ware is the usual coil-made variety without decoration or color. The pressure marks on the outside of the vessel were roughly smoothed over but not obliterated. The natural color is brownish on the outside—gray to blackish within. The firing had been done from the *inside*. This is shown by the blackened surface of the interior and also by the ware having been more burned inside than out, the heavy burning extending to between one eighth and one sixteenth inch of the outer surface. This characteristic of inside firing I have noted in other ware from the region north of the Colorado River. In this connection I may say that the remains of dwellings and the fragments of pottery are exceedingly numerous north of the Colorado River as far as the southern Rim of the Basin, and westerly as far as the Beaver Dam Mountains. Easterly they follow up Green River and its tributaries at least as far as latitude 40. The northwesterly limit has not been determined or even approximated as yet. I believe some remains have been found near Parowan but I was unable to authenticate information at this locality. On the Escalante Desert I found no indications as we crossed toward the Pine Valley Mountains, nor could any one I saw tell me of any. It is, nevertheless, possible that there are both pottery and habitation remains there near springs, and it would be desirable to have the region carefully examined.

On Bright Angel Point, south end of the Kaibab Plateau, I found remains of several very small houses near the brink of the canyon. Some fragments of primitive pottery were lying around and there were two good specimens of the primitive grinding stone—that is, the kind that are hollowed out. These were of red sandstone. The house walls were very slight, the best preserved being about 8 x 22 feet, with a dividing wall in the middle. This was within twenty feet of the edge of the canyon. The stones were roughly dressed in the usual fashion and were so few apparently that the walls must have been very low. I did not have time to dig, but the soil seemed thin.

It is possible that there was a trail down to the Colorado from this promontory. Down below there are remains of other houses and grinding stones of a similar type, which I saw many years ago.

There appears to have been less decorated pottery north of the Colorado River than south, and this might be taken as an indication of a more primitive condition of the art in that region. The potsherds around most of the village sites are apt to be without decoration entirely, or only slightly decorated. Most of the whole specimens found along the valley of the Virgen are undecorated, and are either corrugated or roughly smoothed without the addition of a slip or of lines in color. The shapes are sometimes good, particularly from the Santa Clara district, where some beautiful examples of red ware have been found. The finding of the ruder forms of pottery in a locality may not imply the occupation of that locality by Amerinds of the stone-house-building type for tent dwellers have made rude pottery and the modeling of occasional pots and firing them from the inside seems to have been understood by many tribes of Amerinds south of the Columbia River.

F. S. DELLENBAUGH.

CRAGSMOOR, N. Y.,
July 6, 1903.

SHORTER ARTICLES.

THE RELATION OF LIME AND MAGNESIA TO METABOLISM.

IN a previous communication to this journal (Vol. XIV. (1901), p. 31) the writer discussed some work carried out with Dr. Oscar Loew on the relation of lime and magnesia to plant growth, the results forming the matter of Bulletin 1, Bureau of Plant Industry, U. S. Dept. of Agriculture. Since coming to this station further studies have been made by the writer

in the investigation of the relation of these elements to animal production.

Many analyses show that the percentage composition of plants grown on different soils varies quite noticeably. From Wolff's tables of analyses, for example, the calcium oxide in maize varies from 0.6 to 3.8 per cent., and in meadow hay from 6.0 to 40.1 per cent. of the ash. Wunder found (*Landw. Vers. Stat.* 4 (1862), p. 264) that turnips grown in a clay soil rich in lime contained 9.28 per cent. of lime in the ash, while those grown in a sandy soil poor in lime contained only 5.47 per cent. Emmerling and Wagner report (*Centbl. Agr. Chem.*, 8 (1875), p. 333) that hay from a peaty meadow contained only 6.50 per cent. of lime in the ash, while that from a good marsh soil contained 9.83 per cent. of lime.

It is a well-known fact that the greatest development in live stock has been attained in limestone regions. Opinions differ as to the reason for this, but it would appear that at least the chemical composition of the soil influences the size and the strength of the bone of animals feeding upon the herbage grown thereon. A number of experiments go to prove that the strength and composition of the bones of our domestic animals may be modified by feeding. Notably, Henry found (Wisconsin Station Bul. 25) that the bones of pigs fed on corn with bone meal or hardwood ashes in addition were double in strength of those of pigs getting corn alone, while the per cent. of ash in the bones of the former was 50 per cent. greater. The feeding of mineral matters to quick-maturing animals like pigs is now generally practised, and it can probably be wisely followed with animals of large size and of longer maturity in those regions where there is a deficiency of lime in the soil and a relatively small percentage in the plants.

In our former work we found that there was a relation between the amounts of available lime and magnesia in the soil for the most favorable growth of plants. Loew states with reference to plants (Bul. 1, Bureau of Plant Industry, p. 16) that lime is necessary for the formation of certain calcium compounds of nucleo-proteids required in the organized structure of nuclei and chlorophyl bodies, while magnesia serves for the assimilation of phosphoric acid, since magnesium phosphate gives up its phosphoric acid more readily than other phosphates of plant juices. In case of an excess of lime the assimilation of phosphoric acid will be retarded, because it will combine with the lime and thereby diminish the formation of magnesium phosphate. On the other hand, the presence of an excess of soluble magnesia will tend to the transformation of the calcium nucleo-proteids of the organized structures into magnesium compounds, thereby causing a disturbance that may prove fatal.

In the animal structure lime is very necessary in the formation of bone, and its presence in the blood and tissues of the body indicates the need of it in other organs. Boehm states (*Ber. Akad. d. Wissensch.*, Wien, 1875): "In order to form the cell wall from starch and sugar lime is just as important as for the formation of the bone. The lime forms the skeleton of the cell wall." Again, lime salts have great effect upon the action of the heart, as repeated results have demonstrated. Lime also plays an important part in the division of cells. Herbst states (*Arch. f. Entwicklungsmechanik*, Vol. V., p. 667) that the most important salt for the development of the sea urchin's egg is calcium phosphate, and in its absence the completion of segmentation is impossible.

In this, the blue grass region of Kentucky, the soil has been formed largely by the disintegration of a limestone very rich in phosphates. It is a region long noted for the beauty and quality of its live stock, especially the thoroughbred horse, an animal uniting the greatest speed with endurance. The studies here reported have been undertaken with the view of finding whether in even this favored section the quality of our animals may not be improved by the further addition of certain mineral elements to the food. So far experiments have been carried on with pigs to which varying amounts of lime and magnesia have been given in the feed, noting the rate

of gain and the metabolism of the food given. From the results so far attained with thirty-five animals fed in series of five each, it would appear that there is a definite relation between the amount of lime and magnesia that enters into the animal organism. In the case of added lime, especially with the calcium phosphate, there is an increase in the rate of gain with a reduction of the amount of food required per pound of increase. A very small addition of a magnesium salt also appears advantageous when fed with a lime compound, though the point of benefit is easily passed. Where the magnesium is given regularly in any excess the gain in weight is reduced to a minimum. Though the health of the animal may be apparently unaffected and the coat noticeably smooth and glossy, there is but little gain in weight from the food consumed. Another instance of the action of magnesia may be here noted. In fattening beef cattle for market they are fed large quantities of grain and occasionally become surfeited or, as it is termed, get 'off feed' for several days. By giving an animal in such cases magnesium sulphate it is quickly brought back to its regular ration. In human medicine calcined magnesia is given when the system has become overcharged with food as in some cases of dyspepsia and gout. As the concentrated feeds such as grains are rich in magnesia as compared with lime, while in the growing plant the opposite is true, it seems reasonable to suppose that magnesia operates favorably in the assimilation of food materials when present in the proper proportion, especially in heavy feeding. The results from the presence of lime and magnesia in the animal body in excessive amounts may be somewhat understood from their well-known physiological tendencies, *i. e.*, the lime compounds are constipating, while the magnesium salts are laxative in their nature.

From the effect of lime compounds in the animal body from both a medical and a dietetic standpoint this element may be said to be constructive and fixative in its results. On the other hand, magnesia is more movable in its relation, serving to carry assimilable phosphoric acid, which it gives up readily and is thereby enabled to repeat the process many times. Therefore, a too small amount of magnesia is less detrimental than a deficiency of lime. If, however, with magnesia in excess there is a tendency for the lime as the stronger base to unite with the acid of the magnesium salt and the magnesia to form magnesium nucleo-proteids, such a disturbance would result in the elimination of products rather than in a further constructive effort. In the physiological effect of an excess of magnesia in the animal organism we find such a result indicated.

D. W. May.

Kentucky Experiment Station.

NOTES ON THE EVIDENCES OF HUMAN REMAINS FROM JACOBS' CAVERN.

By the courtesy of Dr. Charles Peabody, Director of the department of archeology, Phillips Academy, Andover, Mass., and of Professor Warren K. Moorehead, curator of this department, the writer was permitted during the month of May, 1903, to examine and assist in excavating a cave in southwest Missouri, in which were found numerous evidences of human occupancy. The cave is located on the north bluff of Little Sugar Creek two and one half miles southwest of Pineville, the county seat of McDonald County, four miles from the Arkansas line and fourteen east of the Indian Territory line. In honor of the discoverer, Mr. E. H. Jacobs, an enthusiastic archeologist of Bentonville, Ark., the cave has been named Jacobs' cavern. To each of these gentlemen are due my sincere thanks for many kindnesses extended during a week's visit to their camp.

The hills along Sugar Creek are composed of massive ledges of limestone containing a large amount of flint and chert, in the form either of regular layers or of nodular concretions. To this formation the name Boone chert has been applied by geologists. It is the rock that outcrops extensively in the southwest part of Missouri, the northeastern part of the Indian Territory and northern Arkansas. In the lower part of the Boone, flint is often absent and the rocks consist of massive gray limestone arranged in definite

layers. To this part of the formation the name St. Joe limestone has been applied. The St. Joe is sometimes sixty feet or more thick, and often weathers into characteristic precipitous or overhanging bluffs extending for miles along the streams.

Immediately beneath the St. Joe limestone is a mass of shales sometimes attaining a thickness of fifty feet, known as the Eureka shales. These shales are usually black and papyraceous, weathering into thin flakes or tablets. Throughout the region thousands of springs issue from between the Eureka and the St. Joe.

Jacobs' cavern is located in the St. Joe limestone some forty feet above the level of Little Sugar Creek. The cave faces southwest, overlooking the narrow valley. The bluff above the cave continues to the height of one hundred and fifty feet or more, the upper part being composed of Boone chert.

The cave is in fact but a rock shelter, irregularly V-shaped in outline, with floor, walls and roof of limestone. The flat top is composed of a single stratum of limestone, and stratification lines are well exhibited on the sides of the cave. Along the front the entire length of the rock shelter is approximately seventy feet; the extreme depth is fifty feet. Before removing any of the contents the height was from four to seven feet. The floor was covered, however, by two deposits, one of clay and one of ashes, aggregating six feet thick, so that the distance from the limestone floor to the limestone roof is approximately twelve feet.

The rock floor was covered to the depth of three feet with clay, usually yellowish-brown in color, containing numerous fragments of limestone. This clay was probably formed by the disintegration of the limestone and so far as noticed has never been disturbed. On the clay was a layer of wood ashes averaging three feet in thickness. Throughout the greater part of the cave these ashes were so loose and dry that the men engaged in removing them were obliged to use sponges in order to avoid breathing the ashes. In fact several of the men were unable to continue the work on this account. Mingled with the ashes and sometimes extending into the subjacent clay were slabs and blocks of limestone fallen from the roof.

At the back of the cave there is a fissure extending upward to the height of ten feet or more, separating the roof of the cave from the rear wall. This fissure, which is probably a master joint in the limestone, is from eighteen inches to three feet wide and continues for some distance beyond the main part of the cave, where it divides into a lower and an upper part separated by a block of limestone.

All along this fissure and also along part of the back of the cave beyond the point where the fissure extends, there are numerous stalactites, stalagmites and pilasters formed by water dripping from the roof. In places the entire fissure above the level of the roof is filled with this material. The continued dripping of water carrying $CaCO_3$ on the ashes covering the floor of the cave has formed a sort of stalagmitic ash breccia often enclosing flint flakes, implements and bones. In these stalagmites charcoal is often present. That this ash breccia was formed gradually and after the deposition of the ashes is proved by the peculiar toadstool-like shape of some of the pillars. It seems from the shape that ashes were first laid down, then the dripping of the water formed the brecciated mass, then other ashes were deposited, other breccia formed, then further deposits of ashes, and so on till the entire pillar was formed. The clay beneath the ashes near the back part of the cave is in many places cemented by the action of lime forming a clay and limestone breccia.

Scattered about in the ashes and enclosed in the stalagmitic breccia at the back of the cave were found a number of objects which point to the fact that the cave has been occupied by man. These objects may be divided into eleven groups, of which seven may be considered as witnessing to human occupancy, and four may or may not bear such testimony. The objects are as follows:

A. Objects witnessing to the human occupancy of Jacobs' cavern: (1) Human bones, (2) pottery, (3) flint implements, (4) stone

implements, (5) bone implements, (6) clam shells, (7) ashes and charcoal.

B. Objects which do not certainly bear testimony to human occupancy: (8) Flint flakes, (9) animal bones, (10) sandstone fragments, (11) polished rocks.

It will be obviously impossible in a paper of this kind to do more than simply mention these objects. All detailed study must be reserved for those more skilled in the discussion of such data.

Human Bones.—Fragments of at least four human skeletons were discovered in the ashes. One of these skeletons, including a skull in a good state of preservation, was nearly complete.

Pottery.—Fragments of at least six vessels were found, including one handle. Several of the fragments were decorated.

Flint Implements.—Chipped flint implements are quite common, more than one hundred specimens having been found. These implements include arrow points, drills, spear points, knives, scrapers, etc., as well as cores from which knives were obtained. The flint is in most cases similar to that found on the hills near by, but in some cases it is believed to have been carried for considerable distances.

Stone Implements.—One large stone mortar was found, as well as hammer stones, a stone hatchet and stones used for sharpening implements.

Bone Implements.—Several awls, needles, scrapers and other implements fashioned from bone were secured.

Clam Shells.—A number of shells of *Unio* were taken from the ashes. At least two genera are represented, both probably being found at the present time in Sugar Creek.

Ashes and Charcoal.—As stated above, the floor of the cave was covered to the depth of some three feet with wood ashes. A conservative estimate would place the amount of ashes at 5,000 cubic feet. Intermingled with the ashes was a large amount of charcoal varying in size from small specks to lumps the size of a walnut. It was in the ashes that the other objects mentioned in this paper were found.

Flint Flakes.—Thousands of flakes of flint were found in the ashes and embedded in the stalagmites. This flint varies in size from small slivers to pieces the size of the hand. Careful search was made along the walls and roof of the cave to detect the presence of flint in the limestone, but without success. There is plenty of flint at a horizon fifty feet higher, but so far as known there is none in the strata in which the cave is located. For this reason it is believed that the flint was carried into the cave.

Animal Bones.—Great numbers of bones of various animals, including mammals, birds and turtles, were found among the ashes and embedded in the stalagmites. These bones have not yet been identified but it is probable that a large part of them are those of living species.

Sandstone Fragments.—A number of small pieces of unshaped sandstone were obtained. The nearest point, so far as known, where sandstone outcrops is four miles distant from the cave, in the vicinity of White Rock. It seems probable that the sandstone has been carried into the cave.

Polished Limestone.—A number of flat limestone slabs that have fallen from above, both just within the cave's mouth and particularly along the foot of the bluff a few feet distant, have been polished or glazed apparently by the friction or contact of greasy bodies. These polished rocks are invariably in such a position as most readily to serve as seats or reclining places for the inhabitants of the cave. There are more than twenty of these slabs that exhibit this peculiar structure.

Charles Newton Gould.
The University of Oklahoma,
May 16, 1903.

NEW TERMS IN CHEMISTRY.

It may not be out of place to call attention to several new terms which have recently been submitted to the English-speaking scientific world and to discuss their merits. However reluctant we may be, in view of possible misunderstandings, to accept new words and phrases, the need of them is often unquestionable, and it only remains for us to determine the proper forms which the words shall take.

The discoverer of a new idea can with comparative ease decide how it shall be expressed in his own language, but when the new word or phrase is translated into another language and there is no one to dictate its form, confusion is very liable to result.

The following terms appear to be slowly creeping in from the German in one dress or another, and, whatever forms the words may have, already assumed in English, it may safely be said that the writers and translators who have used them are more desirous that there should be correctness and uniformity than that personal preferences should prevail.

Mol, or *mole*.—'Gram-molecule' has become so common a word that a contraction of it seems desirable. Ostwald (in German) took the familiar abbreviation of *Molekül*, or *Molekel*, viz., *Mol.*, dropped the period and made it an independent word as a substitute for *Grammmolekül*. The term has already appeared as 'mol' in at least four English texts (three American and one British); Ostwald's translator, however, renders it 'mole.'

The choice between the two words may become easier after a consideration of their merits. 'Mol' has (1) the same spelling as the German original; (2) it is a new word and does not already have several meanings, as does 'mole.' On the other hand, it may be said for 'mole' that (1) it is pronounced like the German original and (2) is its proper and euphonious English equivalent, especially if it is premised that the word is actually of Latin derivation (from *moles*) and that there is no necessity of conforming precisely to the German spelling. Further, (3) 'mol,' if spelled as pronounced, would be 'moll.' Moreover, (4) 'mol' is easily confused with 'mol.,' the common abbreviation of 'molecule.' Inasmuch (5) as 'molecule' is a diminutive of *moles*, or 'mole,' the latter term might very properly be used for 'gram-molecule.' (6) The counter-argument that 'mole' is already in the dictionary with four or five meanings may be discounted by those who regard the addition of one to five as of no great consequence. In the light of the above arguments 'mole' seems to have the advantage, though neither word is entirely satisfactory. Perhaps 'grammole' would be better than either; it has almost every qualification except extreme brevity.

Molar.—We undoubtedly need a word to characterize a solution standardized on a molecular basis (instead of on the usual analytically equivalent basis) and 'gram-molecular,' as well as 'molecular-equivalent,' is too long. 'Molar' sounds well. The principal objection to it is that it already has a meaning in physical science 'opposed to *molecular*'!

If 'molar' is to become the contraction of 'gram-molecular,' 'mole' would be the analogous contraction of 'gram-molecule.'

Metal-ammonia compounds. It is rather difficult for the beginner to understand the German terminology of these interesting compounds, but the English texts, because of lack of uniformity, make the case almost hopeless. One popular text misleads us at the start by calling them 'metallammonium compounds.' English investigators in this field would do well to aid us in securing uniformity.

Hydroperoxide.—An abbreviation of 'hydrogen peroxide.' That *Hydroperoxyd* has much advantage over *Wasserstoffsuperoxyd* is readily seen, but just why we should drop three letters from 'hydrogen peroxide' is not so clear. It should be borne in mind that the *per* in 'hydrogen peroxide' is derived from an unreliable nomenclature. In view of the possibility of the existence of a still higher oxide of hydrogen, either (HO) or HO_{mn}, 'hydrogen dioxide' seems to be the only safe name for the compound H_2O_2.

Activate.—There is probably little objection to the revival of this practically obsolete word to express an effect on a substance by which it is rendered more active chemically.

H. C. Cooper.

Syracuse University.

CURRENT NOTES ON METEOROLOGY.

CLIMATE AND CROPS IN THE ARGENTINE REPUBLIC.

'The Economic Geography of the Argentine Republic' is discussed by J. Russell Smith in the *Bulletin of the American Geographical Society* for April (pp. 130–143),

especial emphasis being laid on the relation of the staple products of the soil to climatic conditions. Argentina is not unlike the region between the Missouri and Mississippi river systems and the watershed of the Rocky mountains. The rainfall decreases towards the interior in both regions, with a corresponding change in vegetation. Argentina essentially duplicates the United States in having in the northeast a rainy forest belt; then a corn belt and a wheat belt; then a wide stretch of semi-arid and arid plain, and at the base of the Andes, agricultural settlements depending upon irrigation supplied by water from the Andean snowfields. In the north, with heavy rainfall, dense tropical forests are found. Cattle extend north even into the district of heavy rainfall in the northeastern territories, while horses do not thrive in a rainfall of more than fifty-five inches in the Argentine, and sheep are found south of the isohyetal line of forty inches. Being able to endure cold and hunger, sheep succeed as far south as the southern shores of Patagonia, and even of Tierra del Fuego. The north, west and south, because of excess or deficiency or unfavorable distribution, of rainfall, are not adapted for wheat, the wheat district being a rough parallelogram in the eastern central part of the country. Corn, owing to its requirement of summer rains and its ability to withstand higher relative humidity, finds favorable conditions in the eastern part of the wheat region, and in the more humid northeast. In the valleys of western Argentina, where water is available for irrigation, crops are grown more independently of rainfall.

KITE-FLYING IN SCOTLAND AND THE CYCLONE THEORY.

UNDER the auspices of the Royal Meteorological Society, for seven weeks during the summer of 1902 kites were flown with great regularity from a tug off the west coast of Scotland. The suggestion of flying kites in this way came originally, it will be remembered, from Mr. A. Lawrence Rotch, of Blue Hill Observatory. Mr. W. H. Dines, in a brief account of the work (*Nature*, June 18), states that, although the evidence from the summer's work was not sufficient to be conclusive, so far as it went it tended to show that as a cyclone approaches the decrease of temperature with altitude becomes less. Every cyclone that passed while the kite-flying was in progress showed this condition. This 'leads to the conclusion,' says Mr. Dines, 'that the upper air in the neighborhood of a cyclone is relatively warm, and that the cyclones are convectional effects.' And thus we have another contribution to the cyclonic theory discussion, which has of late somewhat flagged.

CARBON DIOXIDE IN LONDON RAILWAY CARRIAGES.

THE examination of the air in the carriages and stations of the Central London Railway, carried out by Drs. Clowes and Andrewes (*Nature*, Vol. 68, p. 591) showed in the carriages a maximum amount of carbon dioxide of 14.7 volumes, and a minimum amount of 9.6 volumes, in 10,000 volumes of air. In an elevator, on one occasion, 15.2 volumes of CO_2 were found in 10,000 volumes of air. Dr. Clowes is of opinion that standard air at any point on the railway should not contain more than eight volumes of CO_2 in 10,000 of air.

R. DEC. WARD.

RADIUM AND CANCER.

WE are permitted to print the following letters:

BADDECK, N. S., July 21, 1903.

DR. Z. T. SOWERS,
1707 Massachusetts Avenue,
Washington, D. C.

Dear Dr. Sowers:

I understand from you that the Roentgen X-Rays, and the rays emitted by radium, have been found to have a marked curative effect upon external cancers, but that the effects upon deep seated cancers have not thus far proved satisfactory.

It has occurred to me that one reason for the unsatisfactory nature of these latter experiments arises from the fact that the rays have been applied externally, thus having to pass through healthy tissues of various depths in order to reach the cancerous matter.

The Crookes tube from which the Roentgen rays are emitted is of course too bulky to be admitted into the middle of a mass of cancer, but there is no reason why a tiny fragment of radium

sealed up in a fine glass tube should not be inserted into the very heart of the cancer, thus acting directly upon the diseased material. Would it not be worth while making experiments along this line?

Yours sincerely,
(Signed) Alexander Graham Bell.

Baddeck, N. S., July 21, 1903.

Dr. A. Graham Bell,
Baddeck, N. S.

Dear Dr. Bell:

The suggestion which you make in regard to the application of the radium rays to the substance of deep seated cancer I regard as very valuable. If such experiments should be made, I have no doubt they would prove successful in many cases where we now have failures.

Yours sincerely,
(Signed) Z. T. Sowers.

THE RHODES SCHOLARSHIPS.

The trustees of the will of the late C. J. Rhodes have prepared a memorandum for the information of college authorities and intending candidates for scholarships in the United States, which states that the first election of scholars in the United States will be made between February and May, 1904. The elected scholars will commence residence in October, 1904. A qualifying examination will be held within this period in each state and territory, or at centers which can be easily reached. This examination is not competitive, but is intended to give assurance that all candidates are fully qualified to enter on a course of study at Oxford University. It will, therefore, be based on the requirements for responsions—the first public examination exacted by the university from each candidate for a degree. The Rhodes scholars will be selected from candidates who have successfully passed this examination. One scholar will be chosen for each state and territory to which scholarships are assigned.

The committees and the universities making appointments will be furnished with a statement of the qualifications which Mr. Rhodes desired in the holders of his scholarships, and they will be asked in exercising their right of selection to comply as nearly as circumstances will permit with the spirit of the testator's wishes. They will also be asked to furnish to the trustees as full a statement as possible of the school and college career of each elected scholar, with the special grounds of his appointment, together with suggestions, if desired, as to the course of study for which he is best fitted.

It has been decided that all scholars shall have reached at least the end of their sophomore, or second year work at some recognized degree-granting university or college of the United States. Scholars must be unmarried, must be citizens of the United States, and must be between nineteen and twenty-five years of age. Where several candidates present themselves from a single college or university, the committees of selection will request the faculty of the college to decide between their claims on the basis of Mr. Rhodes's suggestions, and present to the committee the name of the candidate chosen by that college as its representative in the final election.

The president of the state university or college is in each of the following states chairman of the committee of selection for that state:

Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Idaho, Indiana, Iowa, Kansas, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, West Virginia, Wisconsin, Wyoming.

The following chairmen have been named for other states:

Connecticut, President Arthur T. Hadley, LL.D., Yale University.

Illinois, President W. R. Harper, Ph.D., D.D., University of Chicago.

Kentucky, President D. B. Gray, D.D., Georgetown College.

Maryland, President Ira Remsen, LL.D., Johns Hopkins University.

Massachusetts, President Charles W. Eliot, LL.D., Harvard University.

New Jersey, President Woodrow Wilson, LL.D., Princeton University.

New York State, President Nicholas Murray, Butler, LL.D., Columbia University.

Rhode Island, President W. H. P. Faunce, D.D., Brown University.

In the following states appointments will be made by the chartered colleges and universities in rotation:

California, University of California, Leland Stanford University, smaller colleges every seventh year.

Maine (the order of rotation yet to be fixed).

Vermont, University of Vermont, Middlebury College.

Washington (the order of rotation yet to be fixed).

SCIENTIFIC NOTES AND NEWS.

DR. THEOBALD SMITH, professor of comparative pathology at Harvard University, has gone abroad, with a special view to studying the preparation of vaccine virus, which will hereafter be made at the Bussey Institute, of which Dr. Smith is director, under the auspices of the state of Massachusetts.

PROFESSOR FRANCIS H. HERRICK, of Western Reserve University, has been granted leave of absence for the ensuing year. From August 1, 1903, he will be engaged in scientific study in Europe, and may be addressed at Elmhurst, Bushey Grove, Watford, Herts, England. Dr. C. W. Prentiss, of Harvard and recently of the University of Strasburg, Germany, and Mr. Carl B. Tames, formerly an assistant in the biological laboratory, have been made instructors in biology in Western Reserve University, and will have charge of Professor Herrick's work.

DR. CARLSON has been appointed a research assistant by the Carnegie Institution for the coming year and will carry on his work in connection with the Physiological Laboratory of Stanford University and with its Seaside Laboratory on Monterey Bay. The subject of his investigations is 'The Mechanism of Inhibition of the Heart in Invertebrates.'

MR. CHARLES J. BRAND, who for the past year has been assistant in plant economics at the Field Columbian Museum of Chicago, has been promoted to the position of assistant curator, Department of Botany, in that institution. Mr. Brand is a graduate of the University of Minnesota and secured his botanical training under Professor Conway MacMillan.

DR. M. P. RAVENEL, of the University of Pennsylvania, has returned from Europe, where he has been making a special study of tuberculosis.

THE daily papers report that Dr. H. C. Parker, of Columbia University, and Dr. C. E. Fay, of Tufts College, now engaged in explorations in the northern Rocky Mountains, have ascended Mt. Hungabee, the height of which was found to be 11,500 feet, and Mt. Goodsir, the height of which was found to be nearly 12,000 feet.

DR. G. C. MARTIN has sailed from Seattle for the Kayak Island to investigate the oil fields for the Geological Survey.

MR. CHARLES W. WRIGHT has left Washington to make, for the Geological Survey, an examination of the placer gold region known as the Porcupine district. This district lies close to the international boundary, a little south of west of Skagway and about twenty miles from tide water at Lynn Canal.

MR. G. MARCONI is expected to arrive in America about the middle of August.

PROFESSOR H. M. SAVILLE is spending the month of July in Mexico on behalf of the American Museum of Natural History. A part of the time will be devoted to the ruins of Mitla in order to complete his observations and obtain additional photographs for the report on the explorations recently carried on there by the Loubat expedition, and to make further studies of Zapotecan antiquities. While he is in the City of Mexico arrangements will be made for an exchange of archeological specimens between the Muséo Nacional and the American Museum.

FRANK M. CHAPMAN, associate curator of mammalogy and ornithology, American Museum of Natural History, is in California collecting material for making a group on the Cadwalader fund. He has an artist with him, who will make a study of the region in which the birds are found. One of the proposed groups will represent the bird-life of the irrigated portions of the San Joaquin valley,

and will include stilts, avocets, cinnamon teal, coots, all breeding or with young, Forster's and black terns, pintail and redhead ducks, great blue heron and yellowheaded and California redwinged blackbirds. The background will show a great stretch of green irrigated country with the mountains of the Coast Range in the distance.

THE Amsterdam Academy of Sciences has awarded its Buis-Ballot medal, given once in ten years, to Professor Richard Assmann and Dr. Arthur Berson, of the Aeronautic Institute at Tegel, near Berlin.

THE Brussels Académie de Médecine has awarded to Dr. G. Joannovics, assistant at the Vienna Institute for General and Experimental Pathology, the prize of $200 offered for the best work based on new experimental researches. His subject was 'The Pathogenesis of Icterus.'

CAPTAIN HERTZ has been appointed director of the Marine Observatory at Hamburg.

MR. LUTHER STEIRINGER, known for the part he has taken in the development of electric lighting, died on July 18 at the age of fifty-eight years.

PROFESSOR HENRY GRISWALD JESUP, from 1876 to 1898 professor of natural history at Dartmouth College, and author of contributions to local botany, died on the 15th inst. at the age of seventy-seven years.

DR. AUGUSTINE GATTINGER, author of an extensive flora of Tennessee, at one time assistant commissioner of agriculture, died at Nashville, Tenn., on July 18, at the age of seventy-eight years.

WE learn from the *Forestry Quarterly* that Theodor Karlowitsch Arnold, councillor of the Public Lands Office of Russia and known as the father of Russian Forestry, died recently at an advanced age. His work for forestry dates from the forties of the last century and he was directly or through his pupils the teacher of all Russian foresters.

SIR JOSHUA G. FITCH, one of the best known students of education in England, died on July 14, aged seventy-nine years.

BARON DE BUSH, an English chemist, engaged especially in the distillation of essential oils, was killed by falling from a railway train on July 24 at the age of forty-three years.

THE Civil Service Commission announces an examination on August 26, 1903, to secure an eligible list from which to make certification to fill a vacancy in the position of entomological draftsman in the Division of Entomology, Department of Agriculture, at $1,000 per annum.

THE Desert Laboratory, being erected by an appropriation from the Carnegie Institution at Tucson, Arizona, is expected to be ready for occupancy on September 1, when Dr. W. A. Cannon, now assistant in the laboratory of the New York Botanical Garden, will become resident investigator.

ACCORDING to a press dispatch, the Royal Commission which was appointed to examine into the question of London street traffic has decided to send a sub-committee to the United States in the autumn to study American systems of transportation.

THE Eleventh National Irrigation Congress will be held at Ogden, Utah, from September 15 to 18. The program will include: Practical irrigation and forestry lessons; reports of experts; application of provisions of the reclamation act; state progress under the national act; views on settlement of legal complications, and the theme of colonization.

A REUTER telegram from Aden states that the expedition under Mr. W. N. Macmillan, which was proceeding to the Blue Nile, has been abandoned. The boats of the expedition were swamped, but there were no casualties. The members of the party are returning to Jibuti by way of Harar.

WORD has been received at the Geological Survey of the safe arrival on the Yukon of the survey parties under Mr. L. M. Prindle and Mr. T. G. Gerdine, respectively. These parties sailed from Seattle in the latter part of May, equipped with twenty horses. Reaching Skagway about June 1, they found that the lakes of the Upper Lewes River were still frozen, which necessitated a delay of some

ten days. From Skagway the parties went by rail to Whitehorse Rapids, and thence by steamer to Eagle, on the Upper Yukon. From this point Mr. Prindle is to make his way to the southwest, visiting the placer gold fields of the Fortymile region. Mr. Gerdine will begin topographic work, extending a survey across to the new gold district on the Lower Tanana, which Mr. Prindle will examine later in the season.

AT the meeting of the Zoological Society of London on July 16 it was announced that the diving birds' tank and the fish-house would be finished within a month, and the new large aviary on the south bank of the canal in August. Six loose boxes are being erected on the north bank for the accommodation of some of the valuable collections of Equidæ now in the gardens. The work of re-roofing and restoring the eastern and western aviaries had been undertaken. The erection of a suitable building for the accommodation of keepers had been sanctioned and plans were being prepared. The plans for new cages for the birds of prey had been prepared and passed, and the contracts were being arranged. The erection of a new house for small mammals had been decided upon. Plans of the most recent buildings of this nature had been obtained from continental gardens and the erection of the buildings would be forthwith undertaken.

A REUTER telegram from Berlin says that, according to the *National-Zeitung,* Professor Kossel, of the Imperial Health Office, has read a paper at a meeting of the Berlin Medical Society upon the results of the work done by the Tuberculosis Commission in connection with the investigations made by Professors Koch and Schuetz. Professor Kossel summed up the results of a series of experiments as proving that tuberculosis in the human being can be communicated to cattle, and *vice versa.* The practical question—namely, which communication was more frequent and how great was the danger attaching to it—remained, however, still undecided. The results of the experiments, which consisted of the inoculation of calves with human tuberculosis by subcutaneous injection, tend to support Professor Koch's view that the bovine tuberculosis bacillus is of a different species from that of human tuberculosis. A definitive opinion on the point is, however, reserved for the result of a further series of experiments in which inoculation will be made by means of feeding and inhalation.

THE report of the council of the Marine Biological Association of the United Kingdom for 1902–1903, as summarized in the London *Times,* states that the work of the council has this year been considerably augmented in consequence of the fact that a commission has been accepted from his Majesty's government to carry out in the southern British area the program of scientific fishery investigations adopted by the International Conference which met at Christiania in 1901. The share of the international program undertaken by the association includes a scientific survey, by means of the steamship *Huxley,* of the trawling grounds lying between the east coast of England and about 3° 30′ E. longitude. The *Huxley* began her fishing work on November 1. Up to the middle of June the *Huxley* had completed twelve scientific trawling voyages in the North Sea. Over 34,000 fishes have been measured, the majority being flat fish. The animal life of the bottom has been systematically studied from the point of view of distribution, and the food-contents of about 3,000 fishes have been examined and determined. In the investigation of the plaice nurseries near the Horn Reef in May Mr. Garstang was joined on board the *Huxley* by the distinguished superintendent of the Danish investigations, Dr. C. G. Joh. Peterson. Opportunity was thus afforded of repeating investigations on some of the same stations which had been explored by the Danish vessel *Thor* six weeks earlier. The comparison of results revealed certain changes in the distribution of fish in the interval, which were further investigated with definite and interesting results. Plaice have been marked and liberated in various parts of the area south of the latitude of Bridlington. In November and December last the first experiments were

made on the grounds where small flat fish congregate west of the Borkum Reef, and the results obtained are already of great interest and importance. They indicate that during December and January there was a marked migration southwards and westwards of the small plaice previously congregated on the inshore grounds of the northern and western coasts of Holland, the distances traveled being in many cases quite unprecedented—viz., from 100 to 160 miles in six weeks or two months. Over 10 per cent. of the fish liberated have already been recovered. Although it is not proposed to draw conclusions at the present stage of the inquiry, these results already suggest that the supply of flat fish in the southern part of the North Sea, as far south as the Thames estuary, is maintained to some extent by immigrations of small fish from the 'nurseries' off the north coast of Holland. The investigation of fish eggs will not be commenced until the next breeding season. During a recent visit of the *Huxley* to Heligoland for this purpose Drs. Heincke and Ehrenbaum joined Mr. Garstang for a day's fishing, and demonstrated their appliances for this part of the work. Uniform apparatus is now being prepared for next season's investigations. Special assistants are being trained for the work in the markets, but have not yet begun operations away from Lowestoft. The English portion of the international scheme of hydrographic and plankton observations, the execution of which has been assigned to the Marine Biological Association, is to be carried out in the western half of the English Channel. These investigations have for their object the study of the seasonal changes which take place in the physical and biological conditions prevailing over the entire region covered by the international program, though more particularly directed to a study of the waters entering the North Sea from different directions.

UNIVERSITY AND EDUCATIONAL NEWS.

The late Andrew F. Gault bequeathed $10,000 to McGill University, and the will of the late James Cooper gave $60,000 to endow a chair of internal medicine.

The Maine legislature having appropriated $2,500 a year for a department of forestry at the University of Maine, the trustees have authorized the appointment of a professor of forestry.

Cornell University has recently acquired three new farms. These farms, with its campus and original farm give Cornell University about 460 acres of land, 275 of which are available for the use of its College of Agriculture.

By the will of Spencer Morris, formerly professor of medical jurisprudence and toxicology at the Medico-Chirurgical College in Philadelphia, $12,250 is bequeathed to that institution, the income of which is to be awarded annually to the member of the graduating class who receives the highest general average at the final examination for the degree of Doctor of Medicine.

The trustees of Trinity College have established a course in civil engineering to be opened in September next.

Dr. J. E. Duerden, interim professor of biology at the University of North Carolina, has been appointed acting assistant professor of zoology at the University of Michigan.

Professor Norman E. Gilbert, professor of physics and instructor in mathematics at Hobart College, has accepted a call as assistant professor of physics at Dartmouth College.

Professor Albert Lefevre, of Cornell University, has been called to take charge of the Department of Philosophy at Tulane University.

Dr. Irving King, head of the department of psychology and pedagogy in the Wisconsin Normal School, at Oshkosh, has been elected to the chair of psychology and history of education in Pratt Institute, Brooklyn.

The honorary professorship of forestry at the Royal Agricultural College, Cirencester, vacant some time ago by the death of the late Sir Henry Gilbert, F.R.S., has now been filled up by the appointment of Dr. W. Schlich, C.I.E., F.R.S., late Inspector-General of Forests, Government of India, principal professor of forestry, Coopers Hill.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 7, 1903.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*EDUCATION AND THE WORLD'S WORK OF TO-DAY.**

IT is a time-honored custom in connection with the commencement exercises of our American colleges to read an address, for the benefit especially of those who are about to pass from the limited duties and responsibilities of studentship to the wider duties and responsibilities of citizenship. An opportunity is thus afforded for some last words of friendly counsel, and for a review of those ancient academic ideals which, while they have animated generation after generation of our predecessors, have survived them all, and are still a source of inspiration to our contemporaries. But appropriate as this sort of baccalaureate address may have been in the past, it now appears to be somewhat too scholastic for the happy day which marks the end of a college course of study and the joyful entrance of the graduates into the activities of professional and business life. Moreover, a just appreciation of good advice and a generous susceptibility to lofty ideals require a degree of physical comfort and a degree of mental repose rarely attainable in the heat of our average summer day. The solemn lessons of antiquity are losing their force, also, by reason of iteration and reiteration from the commencement plat-

* Commencement address read at Rose Polytechnic Institute, June 11, 1903.

form; so that one may no longer expect to strike a responsive chord, even in classical colleges, by an appeal to the ideas and the ideals of our distinguished ancestors.

It has seemed to me best, therefore, to depart from the beaten track, and to invite your attention to a subject which lies closer at hand; and as the merchant acts wisely in taking stock at the end of his fiscal year, so I trust we, teachers and students alike, may utilize advantageously the end of this academic year to enquire what education is and to what extent it meets the demands of our times.

We all know, of course, in a general way, what education means; but most of us would hesitate, I think, if called upon to give a concise definition of the word. Indeed, those of us engaged in the profession of teaching might be held to be ill-qualified to explain the import of the word. We are so near to the business and so much occupied with its details that we may fail to see it in its true proportions, and hence fail to estimate aright its effects and tendencies. On the other hand, those unacquainted with the elaborate machinery of educational affairs are plainly disqualified, for they lack the precise and intimate knowledge essential to define so comprehensive a term. If we appeal, American fashion, to the majority, it will be found that the consensus of public opinion regards education as a series of routine performances, carried on by means of more or less elaborate methods, involving tasks which students sometimes undertake with joy and sometimes with sorrow, and ending for those who complete the program with a ceremony called graduation. At any rate, this is what we usually mean by elementary education, and we all believe that its administration is desirable, if not essential, to the average boy or girl. And yet I think it would be found troublesome to explain just what is accomplished by this process and why a person subjected to it may be called educated and why one not so fortunate may be called uneducated. Of course, the easy explanation is at hand. We justify the process by its results. These are found to be on the whole elevating to the majority, and so we drift on with the current of public opinion, forgetting, commonly, that while this democratic leveling of intelligence has certain obvious advantages, it has also certain, though perhaps less obvious, disadvantages. And if we enquire what factors should enter into a scheme of elementary education, we at once meet with a confusing diversity of opinion and with the bewildering fact that the schemes already elaborated are so crowded with subjects that there is little chance of adding anything new, and so tenaciously maintained that there is little chance of omitting anything old.

But if we encounter difficulty in defining precisely the meaning and scope of elementary education there would appear to be still greater difficulty in formulating clear ideas as to the meaning and scope of higher education; for with respect to the latter we have to deal with a diversity of opinions which are to a large extent crystallized. Ask the average college-bred man what is the best line of work to pursue in a college course, and he is pretty sure to answer, if he replies spontaneously, that the line he himself pursued is probably the best, or, perhaps, unquestionably the best. Since the average collegian belongs to the traditional school, the average opinion is as unanimous as it is unilateral; and he who expresses it may justly fortify his view by pointing to the excellent results which have come from the pursuit of the time-honored literary curriculum, or, as he would prefer to put it, from the pursuit of the 'classics and the humanities.' Quite

recently, however, in the historical sense, there has arisen a new form of learning, under the name of science, which has now come to be generally recognized as worthy, at least, of a good share of our attention, if it is not comparable in value with the ancient learning; while some of the bolder advocates of science would give it first place in any scheme of education. This new learning, in the comprehensive sense now implied by the word science, is only about thirty years old. But to understand fully its meaning and to appreciate how profoundly it has affected educational matters, one needs to have lived in the prescientific as well as in the present epoch. Suffice it to say here that the advent of science in education was not accomplished without a struggle, which rose at times to a fierceness not altogether creditable to the combatants involved. But though the storm and stress of that struggle, happily, have died away, there remain some controverted questions whose adjustment must be left, perhaps, to you of the present generation to bring about; for we of the prescientific epoch can not discuss them without arousing prejudice which is attributed either to irrational conservatism, on the one hand, or to sweeping iconoclasm, on the other.

I may allude, in passing, to certain forms of this prejudice, and suggest that our sense of humor should help much to dissipate the intellectual fogs which obscure these matters of controversy, and hence lead to solutions which will rest on foundations of merit alone. Thus, even at the present day, many of the older school of education hold, tacitly, if not openly, that studies may be divided into sharply defined categories designated as 'liberal,' 'humanistic,' 'scientific,' 'professional,' 'technical,' etc.; and men and women are said to have had 'a liberal training,' 'a professional training' or 'a technical training,' as the case may be. They say, by implication at least, that mathematics, when pursued a little way, just far enough to make a student entertain the egotistic but erroneous notion that he knows something of the subject, is an element of liberal training. On the other hand, if the student goes further, and acquires a working knowledge of mathematics, his training is called professional or technical. Similarly, studies which include the memorabilia of Xenophon and Cæsar, the poetry of Homer and Virgil and Dante and Shakespeare, or, in short, the so-called polite literature of ancient and modern times, are said to lead to breadth and culture; while studies which include the works of Archimedes, Hipparchus, Galileo, Huygens, Newton, Laplace and Darwin are said to lead to narrowness and specialism; as if the first class of authors were somehow possessed of humanistic traits, and the other class of demoniacal tendencies. So far, indeed, are these distinctions carried that higher moral qualities are not uncommonly attributed to the young man who studies Latin and Greek in order that he may earn a living by teaching them than are attributed to the young man who studies engineering in order that he may earn a living by building bridges which will not fall down and kill folks.

But, you may ask, is it not possible, in spite of tradition, prejudice and conflict of opinion, to lay down some practical precept or working hypothesis that will enable us to proceed along different routes toward the common goal with reasonable hopes of success? Experience during the past thirty years has given, I think, an affirmative answer to this question. We need only to enlarge our definition of education in order to include all that is good in the new learning and to retain all that is good in the old learning. The only im-

perative restrictions are that we must not prescribe the same curriculum for all students, and that we must not entertain invidious distinctions with respect to any of the curricula. According to this view, then, the formal education of schools and colleges does not consist, as many well-educated people seem to think, in the pursuit of certain studies, but rather in the pursuit of some studies thoroughly well. Herein, it seems to me, is the theoretical as well as the practical solution of the whole matter of the conflict of studies. Provisionally, we have pretty generally reached this conclusion in America. It only remains to replace the narrowness which is willing to accept the traditional limits of learning by a breadth which would hesitate to set any such limits.

If we accept this enlargement of our intellectual horizon, and there seems to be no doubt that we shall soon do so, it will be easy to brush away the distinctions which have long clouded our minds, and still affect our judgments, in the classification of studies. The adjectives liberal, technical, humanistic and professional, as commonly used to denote differences or to mark invidious distinctions, will be found to be, usually, misleading or meaningless. All studies conscientiously and laboriously pursued will be seen to be liberalizing and humanizing, whether they be pursued with or without a technical or professional end in view. That it is any more creditable to study the works of Dante and Shakespeare than it is to study the works of Galileo and Darwin will be found to be a frail figment of the imagination, growing out of the supposed holiness of metaphysics and the supposed unholiness of physics.

In the educational transformation that has come about in the last three decades, our schools of science and technology have played an important rôle. It goes without saying that they have demonstrated their right to existence, that they have come to stay, and that they should play a still more important educational rôle in the future. They have won their way to prominence in spite of all opposition; and I think it may be justly said that in thoroughness of work and in the development of the spirit of energy and independence essential to the successful and useful citizen they have already surpassed the older classical colleges. But the strength of their position is measured not so much by academic standards as by the achievements of their graduates. The world no longer asks where and how men have been trained; it goes straight to the point and enquires what they can do. This is the supreme test. That the graduates of our technical schools have met this test successfully is proved by their efficiency in nearly every walk of life. The prominence of their work is especially noteworthy in the great industrial progress of our times. The civil, the chemical, the electrical, the mining, the metallurgical, the naval and the sanitary engineer have established a claim to recognition among the learned professions. Astronomers, botanists, chemists, geologists, geodesists, physicians, zoologists and other so-called specialists have also demonstrated by actual achievements that a scientific training fits men well for the work of the world.

In the meantime great changes have likewise taken place in the curricula and in the attitude towards science of our classical colleges. Most of them have given place in their required or elective studies for the principal sciences. Many of them have limited the requirements in the classical languages to a minimum; while a few of our leading institutions have gone so far as to give the degree of A.B. without any requirement in Latin or Greek.

It is a significant fact, also, that the scientific method and the scientific spirit of investigation have worked striking changes in attitude toward their own specialties among the devotees to ancient learning. Thus they speak of the science of history and the science of theology, and even of laboratory methods in these sciences; and among themselves, teachers of the classics are not infrequently referred to as scientific or archaic, according as they are animated by modern or mediæval ideas. A few eminent educators deplore these tendencies and write regretfully of the vanishing monastic features of college life. A few rail bitterly against what they call 'the materialism of science,' and charge that the perfume of the Attic violet is being stifled by the mephitic odors of the laboratory. Others assert that, while science may be good enough for engineers who build railroads and dig canals, the classics and the humanities are alone fit for the scholar and the gentleman. But the trend of progress is clearly visible in these as well as in other signs of our times. Mediæval methods, customs and ideals are slowly yielding to the reason of modern thought.

Once free from the bias and the restrictions of inherited opinions, education must appeal to us with a broader and a deeper significance. In the best sense of the word, education is a process which should begin in infancy and end only in advanced age. Science has demonstrated that man is a part of, and not apart from, the universe in which we live; and education in the comprehensive meaning of the word is the process of development which fits us to play well our parts in the infinite variety of phenomena which mold us and which we in turn help to mold. Hence the question of education is a many-sided and a far-reaching one, to the larger aspects of which we even who are engaged with some of its formal details can only point the way. Schools and colleges serve only to give the student a start, whence he enters the 'University of the Universe,' from which there are no graduates. Each may choose his own field, and if he would be a master in it he must become a specialist. Of course there are those who decry the present as an age of specialists and speak and write ruefully of former times when the more learned minds were able to compass the entire domain of accepted learning. But those were times when accepted learning was mostly of the kind called 'polite,' times when the rapidly rising sciences and their devotees were referred to with anything but terms of politeness. The change from this not very remote past is irrevocable, however, and it is plainly our duty to make the best of the new conditions, full as they are of novelties and perplexities. The recent great increase in the quantity of indispensable knowledge forces us to a hitherto unheard of division of labor in the educational field. The specialist is, therefore, a necessity, though there never was a time when the qualifications of a specialist were so numerous and so exacting. In fact, it may be truly said that one's training now must be broadly liberal in order that it may be minutely special.

The age in which we live is preeminently the age of educational opportunities. The school, the college, the university, the library and the museum were never so numerous, so free and so efficient as at the present time. Hundreds of experts, in the study and in the laboratory, in the office and in the field, are contributing by their researches to the world's stock of knowledge. Hundreds of literary, historical, scientific and other technical societies are annually swelling the published volume of the world's best learning; while, in a pop-

ular way, the newspaper, the journal and the magazine bring daily, weekly and monthly instalments of this best learning to him who can read it aright. Intercommunication by post and by telegraph, and quick transportation over land and sea are rapidly dissipating class prejudices and supplanting them by friendly rivalries in the common educational advance. The illusions which some eastern institutions have long held with respect to their superiority over institutions in other localities, are rapidly vanishing before the tests of merit and achievement. Indeed, if one may judge from the picked men who pursue work for the higher degrees in our graduate schools, it would appear that the center of education, like the center of population, is no longer east of the Appalachian Mountains.

So far then as opportunities go, the college student of to-day has great advantages over his predecessor of thirty or forty years ago. Verily, no one need thirst in vain for knowledge, for the fountains thereof are to be found flowing on every hand. But, to paraphrase an old saying, while we may point out the fountains of learning we may not be certain that men will drink deeply or effectively therefrom. It seems proper, therefore, to enquire to what extent these available advantages are appreciated and utilized by the average student of to-day.

It would be quite unreasonable, of course, to suppose that the student of the present day is very different from or much abler than the student of a generation or two ago. The capacity of the human mind, like astronomical phenomena, is subject mainly to secular variations. There is no doubt, however, that the great increase in knowledge and the enlarged means for its diffusion, in recent times, have led to a perceptible quickening as well as to a perceptible broadening of the intellectual faculties of men. What may be called the experience of life, and this is, in general, the most important part of education, is begun earlier and is realized in larger measure than ever before. Coming thus to the college or university better acquainted with men and things and pursuing a broader and a more laborious course of study, the graduate of to-day is, as a rule, a better equipped and a more efficient man for the work of the world than any of his forerunners. More is expected of him, more is required of him and more is accomplished by him than in any preceding age.

But while this is the character we may justly attribute to the majority of our college men, there is a noisy minority of them who have succeeded, apparently, in convincing the public, and to a large extent college authorities, that one of the principal functions of an educational institution is the cultivation of muscle and the conduct of athletic sports. Along with the growth of this minority there has sprung up, also, a class of less strenuous men, who, taking advantage of the elective system, are pursuing courses of aimless discontinuity involving a minimum of work and a maximum of play. They toil not, except to avoid hard labor; neither do they spin, except yarns of small talk over their pipes and their bowls. I need not explain to you that these types of men are well known in natural history. From time immemorial the gladiator and the Miss Nancy have received much of that fleeting attention which the careless crowd bestows on the gaudily attired tumblers of the circus and on the transparent masks of pretenders. It is not so well known, however, that these types of men—prospective bachelors of athletics and degree-hunting dudes —are now wielding an influence distinctly

inimical to academic ideals and distinctly debasing to academic morals.

Pray do not misunderstand me. I am not opposed to physical culture and athletic sports. Scarcely any element of education is so important as the attainment of a healthy balance between the intellectual and the physical functions of men. The ancient maxim of a sound mind in a sound body is more fitting now than ever before. We know or ought to know much better than our ancestors to what extent clear thought and right action depend on good lungs, sound hearts and unclogged livers. My protest is not against school and college athletics as such, but against athletics as they are now generally carried on, and especially against intercollegiate contests. As now practiced, athletics seem to me to defeat the object they are intended to attain. They cultivate almost exclusively the men who are usually more in need of intellectual training, and they ignore almost completely the men who are physically defective. The latter are only permitted to stand by and whoop for their alma mater and for her gladiators. Strangely enough, too, the advisers and trainers of our teams and crews are not always men to whom good judgment would commit the training of youth, but they are often men as ignorant of physical culture as they are of mental and moral culture; their names, indeed, are commonly better known to the patrons of the turf and the ring than they are to the patrons of the cap and the gown.

The usually keen American sense of humor seems to have failed us in these matters. Thus the reporters appear to think it essential to state that every distinguished college graduate who dies was a noted athlete in his day, and they often ascribe great prowess to men of a notably opposite physique. One might infer also, from the prominence given to the small number of 'punters' and 'half-backs' of the day, that they are the only college men who are likely to succeed in life. The sporting populace and the sporting alumni go wild with enthusiasm over intercollegiate contests, while the press, in a fashion similar to that followed in describing prize fights, devotes much more space to these ephemeral events than it does to all other educational affairs combined. It is no wonder then that the light-headed undergraduate attires himself like a stable-boy and affects the manners and vices of a cowboy without aspiring to the virtues of either. He may be excused also for entertaining the hypothesis that colleges are athletic clubs, and that his professors, as suggested by Mr. Dooley, will proceed leisurely to take for him the requisite minimum of formalities leading to a degree.

There is a darker side of this question which calls for something more than a quickened sense of humor. It is the vast expense entailed by these extra-academic operations. Fifty to a hundred thousand dollars per annum are certainly not needed by a college or a university to provide adequate physical training for a few athletes and amusement for a few hundreds of men who can not find health and pleasure in more useful occupations. In so far as educational institutions tacitly encourage the practice of this sort of political economy by students, the majority of whom have yet to try their hands at self-support, they must be held guilty of promoting a degree of extravagance which in other walks of life is usually associated with open corruption.

But the fashions, the follies and the fads of college men, like those of any other limited community, play an insignificant rôle in the larger drama of life. However im-

portant to his little circle a student may have been as an undergraduate, he is likely to meet with a chilly reception unless he is well qualified for arduous service in the work of the world. Those who have thus qualified, however, may go forth with confidence; for as ours is preeminently the age of educational opportunity, so is it preeminently the age of professional and business opportunity. There never was a time when talent, energy and enterprise in young men were so much in demand as at present. Men who can plan and execute; men who can work out knotty problems in engineering, in transportation, in sanitation and in finance; and men who can study aright the mighty questions of industrial and social economy now confronting us, are everywhere needed. Above all, there is a demand for men who can see straight, and who can live lives free from moral obliquity; men who can expose the frauds of politicians and the tricks of boodlers and grafters; and men who can demonstrate, by example as well as by precept, that the homely virtues of honesty, industry and sobriety are not dying out in our land.

The world demands men who are not afraid of hard labor; those who would work during a portion, only, of their leisure time, need not apply. The world demands men who are patient and enduring; those who can not find pleasure in business, but who would make a business of pleasure, are not wanted. The world demands men of courage and convictions; those who vacillate and temporize are sure to be beaten in the race of life.

Young men often wonder why they get on so slowly and why the world puts so low an estimate on their abilities. While the element of chance is not wholly negligible in these matters, and while 'influence' and 'pull,' especially in politics, sometimes interfere with 'natural selection,' the reason is generally plain in any individual case. The simple fact is that the world sets severely high requirements for the competent and the trustworthy, and in nine cases out of ten the men who are rejected have failed to pass in these requirements.

Along with the great advantages now afforded for education, and along with the inspiring fields of work now open to educated men there should go a correspondingly high sense of duty on the part of our college graduates. They are in no sense aristocrats, and they would become ridiculous in the assumption of any unproved superiority. Nevertheless, if they are too sensitively possessed of that modesty which is born of a knowledge of things, we may say for them *noblesse oblige* without undue hesitancy. You who go forth to-day, therefore, must assume, if you bear well your responsibilities, new and increasing obligations, obligations to your college, obligations to your country and obligations to your fellow men of the world.

Those of you who have caught the spirit of progress which animates modern science have a special duty to perform. Ours is the epoch of unparalleled improvements and advances. In all that makes for the permanent progress of humanity, the contributions of science in the nineteenth century alone are held by competent judges to compare favorably with those from all other sources throughout historic time. You are among the heirs of these contributions, and it rests with you, in part, to determine what use may be made of them. A flood of light is available, but it would appear to illuminate the intelligence of only a small fraction of our race. When we consider to what extent superstition and error prevail at the present day with the most enlightened peoples of the world, it is plain that the scientific habit of mind is

none too common. We smile, for example, at the folly of the sailor whose fears may be drowned in a pot of beer and who commits his fate to a rusty horseshoe nailed over the entrance to his forecastle. And yet, our 'city fathers' permit epidemics of typhoid fever to prevail with startling frequency and with frightful mortality. Think, too, for a moment of the shocking waste of health and wealth to which the alluring advertisements of quacks and other charlatans bear testimony in the daily and weekly press. Think also of the waste of time and money which comes from the habit of gambling so common in all races from the lowest to the highest. All such vices are deeply rooted in the human family and fortified by our superstitious tendencies to accept without proof anything which promises the marvelous. No mere literary training can help much to overcome this deplorable inheritance. Nothing short of the scientific frame of mind and habits of thought can prevail against such ancestral traits.

There is endless scope, therefore, for additional improvements and advances along the lines your training in science has fitted you to follow. Science bids you look forward, then, with confident optimism. But you should waste no time in idle contemplation of the splendid achievements already attained. The price of progress, like that of liberty, is eternal vigilance. One must be ever active, ever patiently persistent, proving all things and holding fast to that which is good.

R. S. Woodward.

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*THE RELATION OF SCIENCE TO COMMON LIFE.**

I have been honored by being selected to speak to you on the present occasion. The high ideals of this society demand that I should attempt to leave my restricted field of study for a time, and that I should speak of those broader questions that agitate general scientific thought—that I should drop the rôle of the botanist, and assume that of the scientist and the man.

My theme is 'The Relation of Science to Common Life,' the life of the mass of individuals, of the nation, if you will. A very unacademic subject, you will say, as measured by the older standards. I chose it on that account. In not a few university centers, the time has not long gone when such a subject would have been curtly dismissed with the remark, 'We have nothing to do with common life; we follow our own high educational aims.' Too often the universities have stood aside in cold and unsympathetic isolation—shall I not also say in helpless disfavor—while the busy thinking world outside has carried forward the beacon lights of truth and progress. Listen to Whewell when, as Master of Trinity College (Cambridge), he went up to London fifty years ago to deliver his notable address before the Royal Institution. Speaking on 'The Influence of the History of Science upon Intellectual Education,' he said: "I venture to address you, relying upon an indulgence which I have more than once experienced. Of such indulgence I strongly feel the need, on various accounts, but especially that, being so unfrequently in this metropolis, I do not know what trains of thought are passing in the minds of the greater part of my audience who live in the midst of a stimulation produced by the lively interchange of opinion and discussion on the prominent questions of the day." Uttered soon after the exhibition of 1851, and when the scientific world was entering on new conquests, such an apology may seem unaccountable. Happily, our university presidents of to-

* Sigma Xi Society address, June 18, 1903, before the chapter of the University of Pennsylvania.

day are more in touch with the throbbing, vibrating life of humanity, even though they may not claim the profundity of thought that lived in the master of 'Trinity.'

If there be one characteristic more than another of our age and day, it is the steady welding and cooperative development proceeding among the leading races of the world. Nowhere is this seen on so phenomenal a scale as in our country, where, with the Anglo-Celt, Jew and Greek, Frank and German, Italian and Norseman together ply the arts of peace. And why such a commingling of human lives? The answer may be given, and so far well, that here liberty is assured to all, that equal rights and equal opportunities come to all. Back of this, however, is the basic fact that in this country scientific progress has been comparatively unhampered by costly patent laws, by hereditary vested rights, by lands being held in the hands of a few. But perhaps above all, and permeating all, though often silently working, there exists a keen and rapid method of inductive reasoning that carries forward the individual and the community on progressive and yet safe lines. It is this method, applied to all branches of science with increasing exactness, as human freedom increasingly asserted itself during the bygone century, which has culminated in the marvelous scientific position occupied by the country to-day.

Our Sigma Xi Society, as a university organization, stands for 'the nobility of science.' What then is its relation to the university on the one hand, and to the common life of mankind on the other? In reply, let me quickly review the growth of universities during the past millennium. With Lacroix we may regard the University of Paris as the first great effort made by Abelard and his successors to dispel the shades of the dark ages. Here in the four nations met scholars of every language, creed and degree of poverty or wealth. A thirst for learning was their common bond. Later the Universities of Bologna, Padua and Oxford widened and deepened the channel of democratic learning, that spread out and vivified Europe. It is noteworthy that amid all the machinations of emperors, kings, popes and knights the fearless champions of freedom of thought, and so of freedom of the individual, from the tenth to the fourteenth century, issued from the universities, and were often more powerful, and more feared by autocratic rulers, than armed hosts.

But the appearance in succession of Galileo, Francis Bacon, Descartes and Newton, with many lesser lights clustered round, gave rise to that comparatively recent university renaissance which is spreading to widest proportions in our own land and time. We owe it *almost wholly* to the close pursuit of accurate inductive, scientific methods, which have yielded deductions of profoundest value. By slow degrees, through observation and experiment, fact has been cumulated on fact, till these have, in their combined perfection, permitted some great hypothesis to be advanced, or some great law to be deduced, that has grouped all lesser laws in crystal-like symmetry.

But only after the biological inductions and deductions of Lamarck, Spencer, Wallace and Darwin were we in position to apply scientific methods to living things, to man himself. One fundamental keynote of their teachings is that 'Use vindicates and prolongs existence.' The cry is still raised, though from a scattered remnant that is fast being left in the rear of educational progress, that utilitarianism is disastrous to university education and to highest scholarship. This remnant desires

to retain the exclusive spirit and sectarian bigotry that characterized some universities, which had started well but unfortunately were 'captured' for a time by a privileged and unrepresentative few, from the sixteenth to the nineteenth century. John Bright dubbed one of these institutions with cutting but deserved sarcasm as 'the home of dead languages and of undying prejudices.'

Science knows no such distinctions, and refuses to recognize them. She writes deeply on the warp and woof of human and of all organic existence the law that *utility conserves, strengthens and continues life, that disuse weeds out and destroys.* I glory then in the utilitarian, which in the recently gone century has stirred our common human life to titanic action in every field, has revivified and advanced true education, has sown broadcast colleges and universities, and has sent forth from these enthusiastic disciples aglow with the spirit of research and of experiment. This young century, then, before its death, will witness mighty scientific achievement, compared with which all that has been unfolded will be only the prelude.

But here let us linger over the terms use, utility, utilitarianism. It is easy to distort and misconstrue their precise scientific significance. When one looks with the botanical eye at those large, bright-blue marginal florets of the corn-flower, and discovers in them neither stamens nor carpels for fruit production, one is apt to exclaim hastily: 'They are useless, they have no claim to existence.' But patience tells us to watch, to observe and to learn how these attract passing insect visitors to the small inconspicuous central florets, which by aid of the attracted visitors set abundant fruits. The marginal florets seem at first gaudy superfluities, but though they have only one use in life, like the leader of men who had once blacked shoes, they can all claim: 'Didn't I do it well?' Every scientific fact is *useful*, but may not necessarily be *used*. As Darwin patiently dissected cirripeds, studied and described the structure of orchid blooms, observed the slow revolutions of twining plants, counted the number of seeds that different plants might produce, a financial speculator escaped from the unhallowed bedlam of the stock exchange, and looking in on the sage in his quiet country home at the week's end to cool his nerves, might have declared it all a waste of time and labor. We know that Darwin was laying the foundations of those principles that have revolutionized all thought, and that he was paving the way for the economic death of this speculating friend, who biologically is a human parasite.

What relation then has science, and should it have, to our universities on the one hand, and to common life—to the mass of free, earnest thinking people, on the other? In attempting to answer we must constantly keep in view tradition and history—our relation to our ancestors, real or imaginary. We all, like the Chinese, worship these ancestors—at least in their relations—and they worship them most powerfully who are furthest removed from the land that gave them birth. So it is that we fear to break with the past, and inherit incongruous combinations. Says Whewell in the lecture already referred to: "You will not be surprised to be told that our modern education has derived something from the ancient Greek education, because you know that our modern science has derived much from the ancient Greek science. You know that our science—in the ordinary sense of the term—has derived little from the ancient Romans. * * * But if we take the term science in a somewhat 'wide' acceptation, we shall derive from the Roman history

not a negative but a positive exemplification of our proposition. For in that wider sense there *is* a science of which Rome was the mother, as Greece was of geometry and mathematics. The term science may be extended so widely as to allow us to speak of the science of law—meaning the doctrine of rights and obligations, in its most definite and yet most comprehensive form; in short the science of jurisprudence. * * * And thus two of the great elements of a thorough intellectual culture—mathematics and jurisprudence—are an inheritance which we derive from ages long gone by; from the two great nations of antiquity.''

So far Whewell, who in attempting to elevate Roman law to the dignity of a science forgot that much of it was unscientific to the last degree, and tended to produce, not organic national equilibrium, but to set the patricians against the plebeians, and both against the bondmen, who often showed finer qualities than either. Little wonder is it that Rome fell, unsaved by her laws.

Let us see whether a different viewpoint and source of origin for the science of law and equally for all scientific relations might not be obtained. Huxley thus puts it: ''It is a very plain and elementary truth that the life, the fortune and the happiness of every one of us and, more or less, of those who are connected with us, do depend upon our knowing something of the rules of a game infinitely more difficult and complicated than chess. It is a game which has been played for untold ages, every man and woman of us being one of the two players in a game of his or her own. The chess board is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of nature. * * * Education is learning the rules of this mighty game. In other words education is the instruction of the intellect in the laws of nature, under which name I include not merely things and their forces, but men and their ways; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws. * * * The object of what *we* commonly call *education*—that education in which man intervenes and which I shall distinguish as artificial education—is to make good defects in nature's methods, to prepare the child to receive nature's education. * * * In short all artificial education ought to be an anticipation of natural education. And a liberal education is an artificial education which has not only prepared a man to escape the great evils of disobedience to natural laws, but has trained him to appreciate and to seize upon the rewards which nature scatters with as free a hand as her penalties.'' To pursue Huxley's reasoning to its ultimate limit, advanced teaching of all the laws of nature is the highest function of the university in relation to our common life. In other words to make each man who leaves its portals most highly qualified for useful, intellectual, manly life. But, as I hope to show later, this qualification is to enable him to use wisely—not meanly—the forces around him, so as to build society into an organism.

Therefore, every upright pursuit in life which man enters on should have the highest principles and practice governing it represented and taught in our universities, by the best men in the most perfectly equipped manner. This may be an ideal at present. Granted, it is nevertheless one toward which, I am persuaded, every university must move. In this manner science will confer the dignity that is deserved on the physician's scalpel, the bricklayer's trowel, the chemist's test-tube, the engineer's lathe, the biologist's microscope, the

agriculturist's spade or ploughshare. When he saw the spirit of destruction honored and that of construction lightly esteemed, Carlyle rightly growled out as follows in his immortal 'Sartor Resartus': "The Hinterschlag professors knew syntax enough, and of the human soul this much: that it has a faculty called memory, and could be acted on through the muscular integuments by appliance of birch rods. Alas! so it is everywhere, so will it ever be, till an *architect* is hired, and on all hands fitly encouraged; till communities and individuals discover, not without surprise, that fashioning the souls of a generation by knowledge can rank on a level with blowing their bodies to pieces by gunpowder; that with generals and field-marshals for killing, there should be world-honored dignitaries, and, were it possible, true God-ordained priests, for teaching. But as yet, though the soldier wears openly and even parades his butchering tool, nowhere, far as I have travelled, did the schoolmaster make show of his instructing tool; nay, were he to walk abroad with birch girt on thigh, as if he therefrom expected honor, would there not, among the idler class, perhaps a certain levity be excited?" Happily the twentieth century gives promise of emancipation alike from the marshal's sword and the dominie's rod. It is for us to struggle toward securing that honored recognition for every branch of knowledge which Carlyle dimly presaged.

It has often been urged that the intrusion of so-called technical science into our universities will break up all cherished university ideals and dissipate the poetic side of life. Both objections are equally erroneous. Even in acquiring the most technical detail of science, the student can still exclaim with Kepler, in all humility and dignity: 'O God, I think thy thoughts after Thee.'

And as to real poetry and romance, science is just beginning to unfold such. You will forgive me, as a botanist, while I tell you of the wonder and pleasure our students expressed about a month ago, when carried past Jersey fields of scarlet clover in full bloom. This plant had converted former sandy wastes into a floral paradise. But more, our workers had learned the reason for its presence in such quantity, and could picture to themselves the originally scant, but now rapidly multiplying, myriads of 'nitromonas' bacteria that were absorbing and fixing loose atmospheric nitrogenous compounds. They knew that these handed on much of this to the *Rhizobium* organism of the soil or of the clover tubercles, and that finally the fixed assimilated nitrates were utilized by the clover for its sustenance. Truly a romance verified.

Let me try to pick up another with you from the gutter, and illuminate it with the rays of latter-day discovery. Philadelphia every year pours into her rivers millions of tons of sewage. As you are aware, this is rich in all the chemical products needed for plant life, but, like every valuable thing, it must be handled carefully. We have hitherto called it waste, and have puzzled our brains how to get rid of it. One of our railroad companies has found it profitable to build a large viaduct over the Delaware to carry our citizens quickly to the New Jersey coast. No one has yet been enterprising enough to build an equally large aqueduct into which our sewage might be pumped, and ultimately distributed over the thirsty but capable sands of New Jersey, which would blossom into life were such given. To apply the statistics now to hand, 4,000 acres of New Jersey land within ten miles of Philadelphia could then be made to produce the fruits and roots that Phila-

delphians consume, while much of the sewage water might again be collected, and returned to us as hygienic water which might well replace that of the unregenerate Schuylkill. The correctness of every detail of this Berlin has already demonstrated in her broad irrigation system.

In the accomplishment of such truly romantic results the schoolman and the layman, the university teacher and the shop worker, have equally had to do. Already it is recognized that to prepare, cut, stain and microscopically examine a paraffin section, or to separate out the constituents of a chemical mixture, are both liberal educations in which the skilled hand, eye, nose and ear all cooperate with their complex and correlated central manifestation that we call *mind*. Measured by such methods knowledge is not the mental quantity and quality supplied by this or that university, but is the earnest effort of man to enlighten and guide himself and his fellow man.

As brethren of the Sigma Xi then it becomes us to agitate constantly for the restoration of the grand ideals set by Paris and Bologna universities of the tenth to the fourteenth century. There learning was imparted to all who loved it, there nationality, or name, or condition formed no bar to the owner—whose gown at times served to cover his rags, and there the scholars of their day—courted by emperor and entertained by the nobles—were the teachers of these famous old centers. Above all we should so school ourselves as to be ready to slough off during each unfolding year—with its new possibilities for progress—the skin of prejudice or preference that may have hardened round us in the preceding period. The biological teaching of Huxley in '55 was very different from that of '75, and this again from that of '90. In university life the caution is constantly needed. A recent magazine number chronicled the people's vote of three large cities, in favor of municipal ownership of distributive agencies, and somewhat pungently added: 'While the academicians are discussing the theory of municipal ownership the people, in these cities at least, are getting into the habit of voting for it.' Periodic intellectual molting conduces often to sound mental life.

It is a property of most scientific questions that they project themselves into the future. Whether we accept the teachings of Kidd's suggestive couple of volumes or no, his prophetic outlook into the future is inspiring, and despite destructive criticisms his principle of 'projected efficiency' is one that every true scientist tacitly believes in and works up to. We all think of leaving the world better for our descendants—be they fleshly or mental children—and the man who asked in selfish unconcern, 'What has posterity done for me?' deserved no children, and equally deserved that his good deeds should be buried with him. Like that of Paul, our life should be a consecrated unrest. We have not yet attained, neither are we already perfect.

While it will gladly be conceded that few if any countries foster scientific advance more than America, it will as readily be conceded that this has been mainly on the applied side, and that much remains for accomplishment in non-remunerative educational equipment. Here I place in front rank the need for spacious and splendidly furnished museums for all the sciences. Those of us who have walked, time and again, through the mechanical, the chemical, the zoological, the mineralogical and other sections of the South Kensington Museum, or corresponding ones of the continent—not to speak of many local museums of lesser

repute—know that we have nothing to compare with them. Suppose we make observation for a time in the mechanical section, where accurate models may be even seen at work. There the schoolboy lingers inquiringly before them, and he thus forms great conceptions of man's inventive relation to the world forces around him. The factory worker learns how his machines have grown, have been evolved, and how he may possibly perfect them further. For the college and university teacher these collections furnish comparative and concrete illustrations by which a lasting picture is fixed in the mind. Such institutions are costly to erect, to furnish, to man, and to support annually. Their high educational worth must be gauged not by the fruits of years, but of decades and centuries, for the mental stimulus they afford is often hidden away and silent. The question of cost should be a minor consideration in planning such undertakings, amid the corporate and individual wealth that characterizes such centers as our own. Civic pride and loyalty, national pride and loyalty, pride in and loyalty to our highest human development should be sufficient impelling force. Here let me say, with all caution and reserve, but yet with perfect conviction of purpose, that when we read or learn of lavish individual expenditures, for individual gratification alone, it should arouse in every one of us the desire to so mold public opinion that such superfluous ostentations shall cease. If the owner of the wealth thus diverted can be shown that his wealth can most patriotically be expended in building up the country's institutions, then we have successfully done battle for the right. If history has lessons for us, does it not remind us that at one phase of Rome's history the poet could truthfully say,

> "For Romans in Rome's quarrel, spared neither land nor gold,
> Nor son nor wife, nor limb nor life, in the brave days of old,"

and that a later time came when Rome's matrons had few if any robust sons to fight, when the patricians had largely squandered their patrimony in sensual indulgence, when—with decayed institutions—none were 'so poor as to do her reverence.'

Let me suggest another need or couple of needs, easy of fulfilment, and which it behooves us as members of the Sigma Xi to supply. I refer to a graduate and undergraduate society or branch of this one, for general scientific improvement and information. We as graduates and teachers are, or unfortunately in some respects must be, specialists living and working along narrow grooves. A vigorously and comprehensively planned meeting, held once a month, would refresh and expand us all. Picture to yourselves a meeting such as we might have had during the past few weeks with an intellectual bill of fare such as the following: 'The Separation and Properties of Radium,' 'The Biology of Laziness,' 'The Dotter in Naval Practice,' 'The Organism of Smallpox,' 'The Physical Principles involved in the Formation of Mountains' and 'Luminous Bacteria as a New Illuminant.' To finish these in a night would afford a meal worthy of mental digestion for a month. Such meetings would also promote that *esprit de corps*, that common effort, that contagious enthusiasm, that self-sacrificing spirit, which when combined ensure an institution's progress.

Equally would I urge the need for undergraduate organization, though largely for other reasons. Our developing scientists and aspirants to the honors of Sigma Xi should have fullest opportunity for debate, discussion and presentation of views. A

freshness and savor would be imparted to class work that those of us who are teachers desire; it would early promote the spirit of research, and would quicken each speaker to excellence in literary style and oratorical effort. Too little attention is often give to form, and too much to substance, in scientific presentations.

A few sentences back a note of warning was sounded against the dangers of specialization. I trust that every one directly or indirectly connected with our institutions realizes its dangers. Though Darwin pathetically confessed as to its effects, no one has put it more forcefully than Stuart Mill, who says: "The increasing specialization of all employments; the division of mankind into innumerable small fractions, each engrossed by an extremely minute fragment of the business of society, is not without inconveniences, as well moral as intellectual, which if they could not be remedied, would be a serious abatement from the benefits of advanced civilization. The interests of the whole—the bearings of things on the ends of the social union—are less and less present to the minds of men who have so contracted a sphere of activity. * * * This lowering effect of the extreme division of labor tells most of all on those who are set up as the lights and teachers of the rest. A man's mind is as fatally narrowed, and his feelings towards the great ends of humanity as miserably stunted, by giving all his thoughts to the classification of a few insects, or the resolution of a few equations, as to sharpening the points or putting on the heads of pins. The 'dispersive specialty' of the present race of scientific men, who, unlike their predecessors, have a positive aversion to enlarged views, and seldom either know or care for any of the interests of mankind beyond the narrow limits of their pursuits, is dwelt on by M. Comte as one of the great and growing evils of the time, and the one which most retards moral and intellectual regeneration. * * * He demands a moral and intellectual authority charged with the duty of guiding men's opinions and enlightening and warning their consciences; a spiritual power whose judgments on all matters of high moment should deserve and receive the same universal respect and deference which is paid to the united judgment of astronomers in matters astronomical." We must acknowledge, to a large degree, the saneness of Mill's position, but if we all cease specializing one day in the seven at least, the spiritual power desiderated will have opportunity to dwell in our midst. The Jewish Sabbath is by no means the worn-out institution that some would have us believe.

Another rock ahead in the channel of progress demands most careful consideration and steady action. Our present-day political and economic systems often foster methods by which science and scientific discovery are degraded or robbed of their true value, while the scientific worker is often defrauded of that reward that should come from sturdy effort of mind and hand. It has truly been said that 'crafty men contemn studies, simple men admire them, wise men use them.' The founding by Besant of what might be called 'the authors' mutual protection society' marked an epoch in the history of English literature. No such organization has yet been evolved to foster and protect scientific discovery. The attempt has been made in some scientific circles to divorce the discoverer from the fruits of his labors, under the specious plea that it is unprofessional to be associated with these in trade relations. Yet were he allowed or enabled to guide their progress, he would often place them before mankind on a more generous footing than when they are left to be ex-

ploited by some crafty unscientific dealer. But to put the whole question on a much higher plane than that of mere financial well-being, I venture to say that since science stands for accuracy, probity, clear statement of fact, unveiling of error of every kind—whether intentional or unintentional—it can have no sympathy with the deceit and chicanery that are so rampant around us, and that threaten at times even to swamp the high ideals of our universities. Toward the close of his valuable work on 'The Rise of the Swiss Republic,' McCracken says: "It has become somewhat of a commonplace assertion that politics in the United States have reached the lowest stage to which they may safely go. There seems to be no longer any necessity to prove this proposition, for the general conviction has gone abroad, amply justified by the whole course of history, that no democracy can hope to withstand the corrupting influences now at work in our midst, unless certain radical reforms are carried to a successful conclusion. Our calm American complacency seems, at length, to have received a shock; our habitual optimism to have given place to a feeling of apprehension, lest the malignant forces now uppermost in our national life may not, after all, prove too strong for us; and a corresponding desire is being manifested to set in motion other benign forces which shall save the state from destruction while there is yet time.

Unfortunately all attempts to probe the fundamental first causes of our corruption are checked at the outset by the difficulty of bringing the popular will to bear upon public questions. Our whole administrative system, and all the methods by which the people are supposed to make known their desires, are perverted and diseased, so that the sovereign body are prevented by mere tricksters from exerting their legitimate control over the making of the laws which are to govern them. We are suffering not only from deep-seated economic and social diseases, of which perhaps the most alarming symptom is the concentration of wealth into the hands of a few, but from the rule of the boss, and from the lamentable fact that the people at large are divorced from legislation. As a matter of fact nothing stands between us and the tyranny of municipal, state and federal bosses, as unscrupulous as any feudal lordlings in the thirteenth century, except public opinion, imperfectly expressed by the press."

Later he says: 'As for the introduction of the referendum and the initiative into the United States, there are, in reality, no insurmountable obstacles to bar the way.' And again: "Those who have no faith in the principles which underlie all genuine democracies, in the equality and brotherhood of man, and in his natural rights; who fear the people as an unreasoning beast which must be controlled; and therefore look to reform by means of artificial laws, rather than by those of nature—such men will naturally dread anything which savors of direct government, and will of course find the referendum and the initiative a stumbling block and a bugbear. But the increasing number of those who place their utmost confidence in the common sense of the people as a whole 'will welcome both as the most important contributions to the art of self government, which this century has yet seen.' " I have thus quoted at length on a subject that may not seem to be germane to our meeting, but which on a little reflection we can all see should *most* concern *us*. Assuredly all who desire their country's good will acknowledge that the writer speaks forth words of scientific truth and soberness.

The exposure of such existing evils,

here and now, brings us face to face with a biological principle to which we must all bow in attempted improvements or advancement, that of changed environmental relations and resulting modification therefrom. It can fairly be claimed that science has bettered and is bettering the environment of the workers, while it is uniting mankind in ever-widening bonds of unity and cooperation. Holyoake has well said: 'Cooperation is commercial peace, competition is commercial war.' The railroads that make possible scientific congresses, the steamships that link the scientists of continents in annual or triennial reunion, the telephones that almost annihilate phonic space, the food canning that makes life agreeable in every clime are a few of the many environmental products of the past century, that link man to man by chains of amity and peace, and that promote his international well-being.

Are the laws of science then, as we ordinarily understand these, to be our sole guide and rule in life? This inquiry causes me to recur to Huxley's picture of life already quoted. Are all the moves on the human chess board to be dictated only by thoughts of self-interest and self-preservation, or even by thoughts on behalf of our friends and offspring, as Huxley, in his later days, attempted to prove. Some of the 'moves' operated repeatedly in the world's past have given us as an environmental human outcome, products that we call 'strong lives,' 'strenuous lives,' 'unscrupulous lives,' 'useful lives,' 'instructive lives.' But the greatest type, and the one that we almost unconsciously worship is 'the beautiful life.'

Every organism from amœba to man lives by a process that we may call 'organic molecular equilibrium.' When the supplies of life energy and food integration exceed the dissipations and disintegration, growth and development proceed. When both are balanced maturity has been attained. When the converse to the first holds true, decay sets in. Applying this fundamental principle to our common human life, the highest human scientific aspiration might be expressed in the aphorism 'society an organism.' Such a condition society is far from having attained to. But like all organic bodies, if it is rightly to perform its functions, and to perpetuate its like, such it should become. At present, even in its highest expression, it consists of human molecules that often exhibit abundant energy, that undergo permutations and combinations, that show affinities and repulsions, but that lack some form of energy necessary to link them into an organic whole, to give them social equilibrium and stability. Society has been struggling through millennia to become an organism, has been searching for that energy and that source of energy that will give it life equilibrium. At times and in places the result seemed to have been achieved, only again to be impaired, or lost amid a chaos of discords, by the disrupting agency of one or of a few unscrupulous souls, who have acted like a disorganizing ferment on the organizing mass.

Though unfashionable with many to-day, and not least with the followers of science, the only motive form of human energy that has stood the test, and that is stronger today than ever before, is the power, the force of love, of compassion, of sympathy, as communicated by the greatest social lawgiver the world has seen. The early founders of Christianity were charged with it, and for three centuries they shook and finally subdued the Roman empire. We have it in our midst and it lives through all the upheavals consequent on human competition, on commercial war. In our hospitals, in our college settlements, in our

church and public beneficences, in our increased regard for human life, we feel the effects of this energy, though we see it not. The social settlements of Owen and others were truly preliminary nineteenth century scientific experiments to test the strength of the law of love, and the amount of this energy needed to vivify and unify the social organism. Like thousands of scientific experiments before and since they partially failed, but their failures and successes have been recorded, so that succeeding experimenters might carry the inquiry to a successful issue.

The fetish of unbridled commercial competition which has too long lorded over us, is in many ways inimical to our highest interests. It can be a helpful servant if kept in subjection, it becomes a harsh tyrant if worshipped as a god. It can not retain *supremacy* alongside the gospel of peace and love. If so, the latter suffers or becomes effaced, and mankind becomes the loser.

If back of all our failures and achievements, our hopes and our disappointments, some great and desirable human goal is not to be attained, then in spite of the genuine pleasure that comes from discovery of new knowledge, man may well turn from his labors exclaiming, 'Vanity of vanities, all is vanity.' But I thank God that beautiful lives have lived and still live, and that imperfect though I may be, energy—inspiration, if you care so to call it—can be got by drawing supplies of like energy as theirs from the great fountain head that has energized them. The science of life, and the religion of life *may* dwell apart, but who knows whether, when our profound ignorance has been dispelled, it may not appear that both are linked together, and are governed by similar great laws that we are asked by observation and experiment to verify and to accept.

Illimitable fields of research still remain for us to enter; the masses of our fellows are eager to learn what fruits we gather and bring back. We can only afford then to be optimists, and to exclaim with Mackay:

Blessings on Science! When the earth seemed old,
When Faith grew doting, and our reason cold,
'Twas she discovered that the world was young,
And taught a language to its lisping tongue.

J. M. Macfarlane.
University of Pennsylvania.

SCIENTIFIC BOOKS.

Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands and elsewhere collected during the Years 1895, 1896 and 1897. By Arthur Willey. Part VI. (August, 1902). Cambridge (Eng.) University Press. Pp. 691–830, pls. 75–83.

The sixth instalment of Willey's 'Zoological Results' is devoted entirely to an account of the natural history of the pearly nautilus and is by Dr. Willey himself. The account opens with a personal narrative in which he relates, in addition to the many observations bearing directly on the problem of securing the eggs of the pearly nautilus, numerous incidents and occurrences that he met with while sojourning among the inhabitants of the Eastern Archipelago. This is followed by a detailed account of the pearly nautilus itself.

Many interesting and important observations on the natural history of this animal are here recorded. The natural coloration is such that, though the animal is a conspicuous object when in the hand, it is quickly lost sight of when dropped into the sea, a condition which has led Willey to believe that its coloration is of a protective character. Sexual dimorphism in *Nautilus* has long been known and is easily recognized even in the dead shells. Willey has brought to light the remarkable fact that while in *Nautilus pompilius* the males outnumber the females (150 to 66), in *N. macromphalus* the reverse seems to be true (10 to 16). No important information was obtained as to the way in which the

nautilus forms new chambers in its shell. The breathing of the animal is in striking contrast to that of many other cephalopods. In *Octopus*, for instance, the inflation and emptying of the respiratory cavity involves the combined action of the muscular mantle and the funnel; in *Nautilus* the operation is carried out exclusively by the funnel, the mantle being a thin membrane applied to the inner surface of the shell. From the fact that animal bait of almost any kind may be used with success in capturing the nautilus, it is probable that this mollusc feeds naturally on almost any animal substance. Apparently it inhabits normally the bottom of the sea, for those taken near the surface are nearly always moribund. The wounds of injured specimens heal at the edges, but without regeneration. Variation was most noticeable in the disposition of certain unsymmetrical organs. Thus the main siphuncular artery may arise from either the left or the right division of the posterior pallial artery. In one instance a *situs inversus* of the reproductive organs was observed, in that the vas deferens was found on the left side instead of on the right and the pyriform gland was on the right, instead of the left. These and many other new observations on the structure and natural history of the nautilus fill the concluding part of the 'Zoological Results' and bear witness to the energy and patience of Dr. Willey as a field zoologist and explorer, even though in the end he was obliged to abandon his quest for the developing eggs of the pearly nautilus.

G. H. Parker.

Harvard University.

SCIENTIFIC JOURNALS.

The Journal of Comparative Neurology for June contains four leading articles, besides the usual book reviews: (1) 'An Enumeration of the Medullated Nerve Fibers in the Dorsal Roots of the Spinal Nerves of Man,' by Charles Ingbert. There is given a figure of a typical cross section of each dorsal spinal root, with a tabulation of the number of nerve fibers in each fascicle of each root. The total number of medullated nerve fibers in the dorsal roots of the left side of a large man is 653,627; the total area of the cross sections of these roots is 54.93 sq. mm.; there are on the average 11,900 medullated nerve fibers per sq. mm. of cross-section of these roots. This paper will be followed by a similar enumeration of the ventral roots. (2) 'On the Phylogeny and Morphological Position of the Terminal Buds of Fishes,' by C. Judson Herrick. On both physiological and morphological grounds these organs are to be classed with the taste buds of the mouth cavity and not with either tactile or lateral line organs. (3) 'On the Nature of the Pericellular Network of Nerve Cells,' by Shinkishi Hatai. Supports in general the views of Held that this network is composed of the terminal arborizations of axones of other neurones and concludes that the networks of Golgi and Bethe are of the same type. (4) 'The Neurokeratin in the Medullary Sheaths of the Peripheral Nerves of Mammals,' by Shinkishi Hatai. A new technique brings out the details of the structure of the neurokeratin framework more clearly than has hitherto been done. This substance is arranged in two layers, one beneath the primitive sheath and the other along the axis cylinder, which are connected by bands of neurokeratin which run obliquely from the outer to the inner layer in a funnel-shaped pattern. Neither the outer nor the inner layer is interrupted at the nodes of Ranvier.

The statement recently quoted in this journal regarding the establishment of the *Journal for Infectious Diseases* to be edited by Professors Ludvig Hektoen and E. O. Jordan is inaccurate. The journal is supported by contributions from Mr. and Mrs. Harold F. McCormick, but no specified sum has been given to endow the journal. It is to be published by the Memorial Institute for Infectious Diseases, not by the University of Chicago.

DISCUSSION AND CORRESPONDENCE.

THE GRAND GULF FORMATION.

To the Editor of Science: The communication of Dr. Dall on the Grand Gulf forma-

tion in your issue of July 17 seems to call for some comments on my part, since I am originally responsible both for the name and definition of that formation as such. The situation appears to me to be this, that while Smith and Aldrich bring what seems to be irrefragable proof that what I have described as the Grand Gulf formation is newer than any well-defined Oligocene, Dall lays stress upon the reported dipping of the Grand Gulf under Oligocene strata in Florida and Texas, and suggests that the 'Grand Gulf Sandstone' of Wailes is the original genuine Grand Gulf, with which certain clays and lignitiferous strata have subsequently been, perhaps wrongfully, associated.

Now as a matter of fact, Wailes used the term Grand Gulf sandstone merely as a lithological designation, not as the name of a formation; and while he correlates with it the sandstones of some other localities, he describes under the same general heading other light-colored sandstones, belonging, respectively, to the Burstone and to the Lafayette. On the other hand, he distinguishes by the name of 'Davion rock' the undoubted equivalent of the Grand Gulf at and below Fort Adams, Miss. According to usage, I might have adopted any other name for the formation as a whole, since Wailes failed adequately to characterize it. But as I found the exposure at Grand Gulf to be a really generalized and representative one, I thought it best to apply Wailes' lithological designation to the formation as a whole. It rests with me, therefore, to justify my correlation of the sandstone formation of the central portion of the Mississippi embayment with the clay formations from the Pascagoula to the Sabine, leaving to others the proof of identity beyond these limits.

In the absence of specificially identifiable fossils, it is not easy for the field geologist to satisfy the critics at home as to the correctness of his perception of that often indefinable something called *facies,* which is nevertheless oftentimes as cogent as specific identities of fossils, especially with the modern view of species. Even in the absence of the chalcedonization which characterizes the genuine (and rare) Grand Gulf 'petrified sandstone,' the sandstones of the Grand Gulf age can not easily be mistaken in the field for any of those occurring in other horizons in the southwest. From the Bayou Anacoco on the Sabine, via Bayou Funne Louis to Harrisonburg on the Washita, and from Grand Gulf to Raleigh, Miss., its facies, both lithologically and stratigraphically, is unmistakable, although the chalcedonized rock facies is mostly absent and everywhere, except at Grand Gulf, quite subordinate; mostly in thin ledges or lenticular masses. The sandstones, mostly rather soft, tend to cleave vertically rather than horizontally, and are markedly poor in mica.

The clays occurring interstratified with sandstone layers and ledges are sometimes, but not always, as characteristic as the sandstone itself, but much more so when occurring independently in large masses, as is especially the case on Pearl River and its tributaries. Doubtless the physical analysis of these massy clays, which range in tint from blue and green to reddish-gray, would be found to indicate the characteristics which render them so strikingly dissimilar to those of other formations of the southwest, whether older or later. One of their characteristics is the almost total absence of mica, which is so abundant in the earlier Tertiary as well as in the later Lafayette and is there conducive to the prevalent lamination; indicating apparently a derivation from different sources, not so far inland as to reach the micaceous metamorphics. The clays mostly contain a very large proportion of fine siliceous silt, so that while plastic they are not usually very adhesive. They are (especially in Louisiana) not infrequently consolidated into a soft siliceous claystone.

A highly interesting feature of the Grand Gulf clays is the local occurrence of calcareous concretions and veins, which I think may fairly be attributed to the presence, locally, of a rather copious fauna of shells, whose shape has been destroyed by maceration. In the calcareous clays underlying the 'Anacoco Prairie' in western Louisiana, many of the

concretions can almost as readily be construed into the forms of Natica, Nerita and Paludina as they are shown in the somewhat similar clays of the Port Hudson age, on the islands of Petite Anse and Côte Blanche. Here every degree of transition from the almost perfect shell into the roundish concretions can be traced; and I do not despair of a similar state of things being found within the largest calcareous deposit of the Grand Gulf area on the Anacoco when it shall be examined more at leisure than it was possible for me to do in 1869.

So far then as the central portion of the Grand Gulf formation in Mississippi and Louisiana is concerned, I see no escape from the conclusion that the sandstones and associated clays are rightly considered as being of one and the same geological age and formation, whether representing the upper Oligocene or later stages of the Tertiary. The hiatus between it and the Lafayette is emphasized alike by the extension of the latter two hundred and fifty miles farther inland, and by the totally changed lithological character of the materials, a change so great that it is hard to believe that the same Gulf waters should have produced both at any short interval of time. The conformity of the Lafayette to the Grand Gulf, referred to by Dr. Dall, is rather a delicate question when dealing with a formation of which stratification lines and dips are hardly predicable. The Lafayette overlies the Grand Gulf as it overlies every other formation in Mississippi and Louisiana, and it is there undoubtedly the next succeeding formation; but intervening beds may be found elsewhere. What was the nature of the event that caused the remarkable change in the whole nature and distribution of the two deposits must still, I think, be considered an unsolved problem.

E. W. HILGARD.

BERKELEY, CAL.
July 22, 1903.

ANTARCTICA.

TO THE EDITOR OF SCIENCE: My many American friends will be amused by the innuendo that I hate Americans which runs through Mr. Balch's notice (in your issue of July 10) of my review of his book in the *Geographical Journal* for May. It has always been a privilege of men of science to criticise each other's work as if they were members of one family, and I can conscientiously say for myself that I am without prejudice as to race, creed or nationality. Should I or any other European geographer differ from Mr. Balch or Fanning or Morrell, it is not because they are Americans and we are not, but because we think that in certain points they are mistaken.

The Atlantic is too wide for a comfortable controversy in a weekly journal to be conducted across it; and I do not think it would serve any useful end to reply to Mr. Balch's letter in detail. I fear that my review is too long for you to reprint, but nothing shorter would give a correct impression of my opinions on the points dealt with in Mr. Balch's very stimulating book. I should be glad if both were widely read.

Yours is a land of millionaires; the Antarctic is still scarcely touched by explorers, and all nations would rejoice to see a well-equipped American expedition sent out to help to solve the present problems which after all are those most nearly concerning us.

HUGH ROBERT MILL.

62 CAMDEN SQUARE, LONDON, N. W.,
July 21, 1903.

SHORTER ARTICLES.

A NEW MOSQUITO.

SINCE mosquitoes have attracted so much attention of late through the part they play in the transmission of certain diseases, anything new that pertains to them or their life history may be of importance. In view of this fact, a brief description of a new species—which has been given the name of *Eucorethra underwoodi*—should be of interest. While this particular insect does not bite, and for this reason should not perhaps be regarded as a true mosquito, it has, however, been classed as one since it belongs to the family Culicidæ. The larvæ of this insect were found by me on January 27, 1903, in the Maine woods in the eastern

section of Penobscot County, and were discovered in a spring of water from which a crew of lumbermen were getting their water supply. A few days later, I found other larvæ of the same species in a similar spring about eight miles distant, though in this case, as the spring was not in use, it was covered with a coating of ice an inch thick. The temperature of the water at the bottom (it was about two feet deep) was 42° F.

At first sight this larva would be taken for an *Anopheles* of extraordinary size, as it is of the same general shape, and when the water was cleared of ice, it lay just beneath and parallel to the surface, breathing through a short respiratory siphon, as is characteristic of the larvæ of *Anopheles.* In this spring a barrel had been sunk and in the fifty gallons, or thereabouts, of water which it contained there were twenty-five larvæ. They were all of about the same size—12 to 14 mm. long—and almost black in color. All were secured and taken into camp for further investigation. Here they were kept for thirteen days at a temperature varying from 32° at night to 65° or 70° during parts of the day—an average temperature of about 45° F.

Close observation of the larvæ now showed that besides being much larger (12–14 mm. long instead of 5–7 mm.) they differed in many other particulars from the larvæ of *Anopheles.* In proportion to the rest of its body, its head is larger than the head of *Anopheles.* It does not turn its head upside down when feeding as does *Anopheles.* Its mandibles are strikingly large and powerful and are prominently toothed. It lacks the frontal tufts or brushes which are conspicuously present in *Anopheles,* and its antennæ, which extend directly forward parallel with the sides of the head, are much longer and more slender, and are tipped each with three hairs of equal size. The thorax is broadly elliptical and is much wider in comparison with its abdominal segments than is the thorax of *Anopheles.* The sides of the thorax and the abdominal segments bear fanshaped tufts of hairs, not plumosed as in *Anopheles.* The tufts on the last segments, both dorsal and ventral, are more profuse in *Eucorethra* than in *Anopheles,* especially the ventral tuft which in *Eucorethra* occupies nearly the whole segment. Only two anal papillæ are present, while *Anopheles* has four.

A few days before I returned to Boston, several larvæ died and three changed to pupæ. The pupa resembles that of *Culex* rather than of *Anopheles* and its respiratory siphons are of the same shape as in *Culex.* When stretched out at full length, the pupa measures ten mm.

On reaching home, the new wigglers, eighteen in number, were put into a quart jar which was placed near a window where it would receive the sunlight for two hours each morning. The temperature of the water now averaged about 70° F., and with this change the larvæ developed a new trait—they began to eat each other up. I witnessed the act on several occasions. The larva would grasp its adversary just forward of the respiratory siphon with its powerful mouth parts, and working the tail in first it would gradually swallow its victim, shaking it now and then as a terrier would shake a rat.

After losing a part of my stock in this way, those that remained were separated, and each individual was placed in a small bottle by itself. Eventually, I succeeded in rearing a number of males and females. The pupal stage of this insect varies from five days and nine hours to six days and ten hours. The adult resembles *Anopheles* in having maculated or spotted wings, but is much larger and measures eleven millimeters in length. Its mouth parts, however, are not adapted for biting. A full description of the imago is soon to be recorded by Mr. D. W. Coquillett of the National Museum by whom the name above mentioned was given.

Drawings were made of all the different stages and on May 26, 1903, they were sent to Dr. L. O. Howard, chief of the Division of Entomology, at Washington.

On July 24, word was received from Dr. Howard that a new genus had been made for the insect and that Mr. D. W. Coquillett had named it *Eucorethra underwoodi.* I was also

informed that the same insect had been sent in during July from British Columbia where it had been found by Dr. H. G. Dyer, who was collecting for the department.

During a visit to Maine in June, a large number of larvæ of *Eucorethra* were taken from the spring where the barrel had been sunk. It was noticeable that larvæ of other kinds of mosquitoes were absent, although the adults were very numerous in the immediate vicinity. During the past month many more larvæ have been sent me from the same source.

I found that they were very fond of the larvæ of the different species of *Culex* and that they ate them, apparently with great relish. On several occasions fourteen *Eucorethra* larvæ ate, during the night, sixty *Culex* larvæ out of the seventy that had been placed in the water with them. When eating the larvæ of mosquitoes smaller than themselves, the victim is caught, shaken violently a few times, and swallowed in a few seconds in very much the same way that a pickerel would catch and swallow a smaller fish.

As yet no experiments have been made to see if this new species will devour the larvæ of *Anopheles* as readily as they will those of *Culex*. Whether or not this species will thrive in the climate of southern New England is as yet uncertain, but experiments are now being carried on to determine this point.

Wm. Lyman Underwood.
Mass. Institute of Technology,
Boston.

THE ASCENDING OBELISK OF THE MONTAGNE PELÉE.

Not the least remarkable of the many extraordinary conditions that have been associated with the recent eruptions of the Martinique volcano is the extrusion of the giant tower of rock, a veritable obelisk, which to-day dominates the mountain, and which has given to it an added height of 800 to 900 feet. Pelée is no longer 4,200 or 4,428 feet in elevation, but upwards of 5,000 feet. On May 31 last, before it lost 180 feet of its summit, it reached exactly 5,200 feet. This tower of rock, the nature of which was first properly made known by Professor Lacroix, issues directly, and to all intents and purposes vertically, from the summit of the new cone of the volcano (of whatever precise nature this cone may be) which had been built up in the ancient crateral-basin (the Étang Sec) to a height of 1,600 feet or more, and virtually plugs it. Where it is implanted, it has a thickness of some 300 to 350 feet. From certain points of view the obelisk seems to maintain for most of its height (800+ feet) a fairly uniform thickness; from other points it shows a rapidly tapering surface, with a termination in a needle summit, a true *aiguille*. It is gently curved or arched toward the southwest, or in the direction of Saint Pierre, and on this face it is cavernous or openly slaggy, showing where successive and repeated explosions had carried away portions of the substance. On the opposite side, or toward the east-northeast, the surface appears solid, is smoothed and even polished in part, and shows longitudinal parallel grooves and striæ, very much like glacial markings. On this side it shows plainly the marks of hard attrition, the effect of rubbing upon the encasing rock—the mold, in fact, that determined a portion of the exit-channel.

The constitution of this extruded 'cork' is undeniably lava—a lava whose viscosity or rapid solidification did not permit it to flow over, but which under the giant stress of the volcano simply moved upward, solid from base to summit, and receiving accretions to its mass only from below. The most cursory examination of the relations existing would immediately point to this form of growth and development, but the carefully conducted angle-measurements and observations of contour made by the representatives at two stations of the French Scientific Commission leave no possibility of doubt in the matter, and they further furnish us with data touching the rate of growth. Thus, in eight days preceding June 7 this growth was, as we are informed by M. Giraud, ten meters; and in the four days preceding June 15 (a period within the time of my recent visit to the volcano) it measured six meters. The consideration of the depth to which this giant

monument descends solid into the volcano would be interesting were there any way of reaching the problem, but for the present there would seem to be none such.

On June 13 last, in company with M. Guinoiseau—one of the observers of the French Commission—I made the ascent of Pelée, and from the immediate crater-rim took a series of photographs of Pelée's singular process, probably the most impressive piece of nature that I had ever seen. The volcano, by comparison with what it had been before, had 'slumbered down to peace,' but yet it was too active to permit us to descend into the crateral-hollow, 300 to 350 feet in depth, that still surrounded the new cone. Steam- and sulphur-puffs were issuing everywhere, and avalanches of rock were repeatedly being disengaged from the obelisk. Pelée was still 'ugly,' and the night before, the southwest base of its crown or plug was glowing with fire—with the liquid lava that was rising in rift-passages. Two days later I noted a feeble line of steam issuing from the absolute apex of the summit, suggesting a continuous passage or channel extending from base to summit. On March 26 a discharge of incandescent balls was observed also to take place from the same position.

Geologists will naturally make a comparison between the Pelée structure and that which was observed to rise in Georgios, in Santorin, in 1867; but the dome of the latter is probably nearer to the cone of Pelée, and suggests little of the obelisk and of its method of formation. And, perhaps, not much more can be said in any comparison that might be made with the 'pyramidated' summits of some of the equatorial volcanoes of South America, whose contours have been given to us by Professor Stübel.

Angelo Heilprin.
Geographical Society of Philadelphia,
July 18, 1903.

CURRENT NOTES ON METEOROLOGY.

HEALTH ON THE ISTHMUS OF PANAMA.

In a recent number of the *Monthly Weather Review* (Vol. XXXI., No. 3) General Henry L. Abbot, who has for some years made a special study of the climatological conditions of the Isthmus of Panama, publishes a summary of the climate and health of that district which will prove of general interest at the present time. General Abbot has previously written several discussions of this subject, some notes on which have appeared in these columns. Probably what General Abbot has to say about health on the Isthmus will have the greatest interest just now. Regarding the earlier health statistics, during the construction of the Panama Railroad, it is stated that they 'are well known to have been appalling.' But, as is pointed out, "at that date it was not understood that natives of the temperate regions can not safely perform arduous manual labor under exposure to a tropical sun, and that dependence for such work must be placed upon the negroes of the West Indies. White men can supervise, but must not attempt more." The table of 'Official Health Statistics' of the Panama Canal, published in the article, may be briefly summarized as follows:

Old Company, 1881–1888, percentage of mortality from disease (European and tropical), 5.97.

Receiver, 1889–1894, percentage of mortality from disease (European and tropical), 2.88.

New Company, 1895–1901, percentage of mortality from disease (European and tropical), 2.61.

The marked improvement shown in recent years is attributed by Dr. Lavoisade, the medical director of the company hospital near Panama, to the better accommodations of the laborers, better drainage, and especially to the fact that the excavations have reached a level below the poisonous emanations of decaying organic matter. For the years 1898–1901 the percentage of mortality from disease was 2.35, which is said not to exceed that on large works in any country. The men herein concerned had, however, been long on the Isthmus. As to yellow fever, the disease most to be feared by unacclimated persons of the white race, during two recent epidemics (in 1899 and 1900), only two cases appeared among the personnel of the company. Dr. Lavoisade believes that yellow fever 'is in no wise necessarily endemic' on the Isthmus.

CLIMATE AND RAILROADING.

As the subject of a thesis in the course in General Climatology in Harvard University, Mr. Robert M. Brown took 'Climatic Factors in Railroad Construction and Operation,' and some of the results of the study are embodied in an article under the above title in a recent number of the *Journal of Geography* (Vol. II., pp. 178–190). For purposes of classification the different districts of the world are arbitrarily grouped as regions of heavy precipitation; of moderate precipitation; of light precipitation; of high altitudes and of severe winters. In each of these regions there are climatic difficulties which must be solved by the engineers and operating officials during construction, and after the road has been built. Where the rainfall is heavy there is decay of ties, sleepers and bridges; there are floods and landslides. In regions of light rainfall there is great danger of fire; water must be piped for long distances or else carried in tanks; labor is often difficult on account of the heat; sand is blown by the wind, accumulating on the rails, blinding the drivers, and injuring the machinery. When the altitude is high, mountain sickness, snow blockades and snowslides must be overcome. In regions of severe winters ice breakers may be needed to keep open lakes and rivers, or temporary rails may be laid on the ice; snow and ice hinder construction and operation, and the number of working days may be seriously reduced. Mr. Brown mentions specific instances to illustrate these various climatic controls, and the article is a distinct contribution, albeit an incomplete study in itself, on the human side of climatology. It so happens that three railroads now building, or projected, furnish numerous excellent examples of the kind of control considered in Mr. Brown's paper. These are the proposed Trans-Canada and Trans-Australian lines, and the Uganda Railway. The former is interesting because of the high latitudes which it is to traverse; the second, because its route lies across the central arid portion of Australia, and the third by reason of its being in tropical Africa.

R. DeC. Ward.

Harvard University.

RADIUM AND HELIUM.

A paper bearing in a remarkable way on the connection between these two elements, which is now exciting so much interest, has been received for publication by the Royal Society from Sir W. and Lady Huggins. Prompted, in fact, by theoretical ideas, they attacked the problem of the spectroscopic analysis of the light emitted directly by a radium salt at ordinary temperatures. Preliminary visual observation seemed to show traces of bright lines in a continuous spectrum. Preparations were accordingly made for photographic record by means of a small quartz spectroscope constructed some years ago for use on very faint celestial objects. After several trials, a spectrum, consisting of eight definite bright lines in the ultra-violet, entirely different from the spark spectrum of radium, and some faint lines together with a very faint continuous spectrum, was obtained by 72 hours' exposure to the glow. The lines were of some breadth, on account of the wide slit that had to be employed in order to admit sufficient light; but it was found possible to measure their wave lengths within an error of two in the fourth figure. On a comparison of this spectrum, so different in type from an ordinary phosphorescent spectrum, with the recorded measurements for helium, it appeared at once that four, and perhaps five, of the eight lines agreed with lines of helium within the uncertainty of the measurements. Another line, that of the highest refrangibility, agrees with a line in the spark spectrum of radium itself, which, however, has not been recorded by other observers; the two other lines, the lowest, have not yet been traced.

It will be remembered that last year Professor Rutherford produced striking evidence for the view that, in the very slow break-up of radium that is concomitant with its radioactivity, the inert gas helium is one of the products formed. Recently Sir W. Ramsay and Mr. F. Soddy have succeeded in detecting helium by the spectroscope in the gases extracted from a radium salt. If, as the present observations indicate, the radium salt shines spontaneously in the dark largely by light belonging to the different element helium, an-

other important step is gained in elucidating the nature of the instability of such chemical elements of high atomic weight and the radioactivity associated with it.—The London *Times.*

The possibilities of such mysterious forces as those possessed by radium present an attractive field of speculation for the physician. May not the radiant energy emitted by radium possess pathogenic as well as curative, destructive as well as stimulating, powers on cells and cellular processes? Perchance, it may be forces of this kind that upset physiologic laws of cellular activity, and lead to abnormal proliferations of various kinds? But questions of this kind are not yet ripe for discussion. Actual experimental studies must furnish the necessary basis of facts from which it may be permitted to draw further deductions. Danysz found that radium destroys the skin of guinea-pigs and rabbits, but subcutaneous and muscular tissue do not seem so sensitive as skin. The nervous tissue is also sensitive to its action. A sealed glass tube with salts of radium placed against the skin over the spine is followed by death in young animals. In older animals the osseous tissue seems to protect the spinal cord against the radiations. The effects of rays of radium on bacteria have not been studied extensively as yet, but both Danysz and Bohn show that various larvæ and embryos are profoundly modified in their growth, many being killed when subjected to the radiations; others developing into monstrosities because of unequal stimulation. Bohn further finds that radium exercises an especially intense action on tissues or cells in proliferation; non-fertilized eggs may undergo more or less parthenogenetic development and give rise to atypical formations. It has been found, too, that in animals whose skin was burned by the rays, the hair, in some cases, appeared to be forced into rapid growth. It seems that various effects are obtainable, depending on the tissue or cell exposed, as well as on the quantity and quality of the rays. Further experiments, no doubt, will yield even more interesting and conclusive results. We have commented on the announcement that in Vienna cancer has been cured by means of radium. In this particular direction much work will surely be done, and we may expect interesting developments.—*Journal of the American Medical Association.*

SUMMER WORK OF THE GEOLOGICAL SURVEY.

THE preliminary arrangements for the present season are as follows:

Adams, Dr. George I., assistant geologist, will complete study of northern Arkansas lead and zinc district, with some revision of Yellville and Fayetteville quadrangles. On its completion, associated with Dr. Erasmus Haworth, will make an areal and economic survey of Iola thirty-minute quadrangle, Kansas. Later will make reconnaissance of stratigraphy of Coal Measures and Permian in northern Texas.

Alden, Wm. C., assistant geologist, will continue work on Pleistocene geology of quadrangles in southeastern Wisconsin.

Arnold, Dr. Ralph, geologic aid, will assist Dr. Wm. H. Dall in completion of monograph on southeastern and Florida Tertiaries, and Dr. J. C. Branner on the paleontology of the Santa Cruz quadrangle, California.

Ashley, Dr. George H., assistant geologist, will complete, under supervision of M. R. Campbell, study of Cumberland Gap coal field, in cooperation with state of Kentucky.

Atwood, W. W., assistant geologist, will assist Professor R. D. Salisbury in glacial work west of one-hundredth meridian.

Bain, Dr. H. Foster, geologist, will begin systematic study of lead and zinc deposits of Mississippi valley. Will make detailed surveys in southern Illinois and in Galena district in northwestern Illinois; and will visit points in Wisconsin and Missouri for cooperation with state surveys.

Bascom, Dr. Florence, assistant geologist, will complete necessary field work and prepare for publication the Philadelphia Special folio, embracing four fifteen-minute quadrangles.

Bayley, Dr. W. S., assistant geologist, will survey crystalline rocks of Raritan quadrangle, New Jersey.

Boutwell, John M., assistant geologist, will complete investigation of mining geology of Park City district, Utah, and make a reconnaisance of Coalville quadrangle.

Branner, Professor J. C., geologist, will continue areal work in Santa Cruz quadrangle, California, and prepare the folio for publication.

Brooks, Alfred H., geologist in charge of geologic work in Alaska, will continue supervision of geologic work in Alaska. Will visit the Spencer party at Juneau, and later spend six weeks in company with L. M. Prindle in visiting region of lately discovered placer gold fields in Tanana Valley. Latter part of season he will spend in Seward Peninsula visiting the Collier and Moffit parties.

Butts, Charles, assistant geologist, under supervision of M. R. Campbell, will continue areal and economic surveys on quadrangles in western Pennsylvania, in cooperation with state.

Calhoun, F. H. H., assistant geologist, will assist Professor R. D. Salisbury in glacial work west of one-hundredth meridian.

Calkins, F. C., assistant geologist, will assist Dr. F. L. Ransome in study of areal and economic geology of Cœur d'Alene mining district, Idaho. Later in the year will assist George H. Eldridge in areal work in southern California.

Campbell, M. R., geologist, will have immediate supervision of areal and economic work in Appalachian coal field.

Chamberlin, Professor T. C., chief of section, will continue supervision of investigations of Pleistocene geology of United States.

Clapp, Frederick G., geologic aid, under supervision of M. R. Campbell, will continue areal and economic surveys on quadrangles in western Pennsylvania, in cooperation with state.

Collier, Arthur J., assistant geologist, will make careful investigation of gold placers of Seward Peninsula, Alaska, with view to supplementing hasty reconnaissance work of previous years. Will also undertake some areal mapping and stratigraphic studies in this region.

Crane, Professor W. R., field assistant, will assist Dr. Geo. I. Adams in the measurement of gas pressures in connection with the survey of Iola thirty-minute quadrangle, Kansas.

Cross, Dr. Whitman, chief of section, will continue investigation of areal geology of San Juan district, Colorado, and have general supervision of investigations in petrology throughout the United States.

Dale, Professor T. Nelson, geologist, will continue investigation of areal and economic problems in western Vermont, and survey the Brandon quadrangle for folio publication.

Dall, Dr. Wm. H., geologist and paleontologist, will be occupied during greater part of year in completion of monograph on southeastern and Florida Tertiaries. On completion of that work he will take up study of invertebrate Tertiary paleontology of Pacific coast.

Diller, J. S., geologist, will complete areal and economic survey of Redding quadrangle, California, and make general reconnaissance of geology of Klamath Mountains.

Dominian, Leon, field assistant, will assist J. E. Spurr in completion of economic investigation of Tonopah mining district, Nevada, and in economic geology work in Silver Peak quadrangle, Nevada.

Eckel, Edwin C., assistant geologist, will make detailed investigation of cement industry of United States.

Eldridge, George H., geologist, will spend first half of year in completion of reports on Florida phosphates and California oil fields. Later in season will take up areal work in southern California.

Emerson, Professor B. K., assistant geologist, will continue work on areal geology of central Massachusetts.

Emmons, S. F., chief of section, will be occupied throughout the year with supervision of investigations of metalliferous ores and completion of report on geology of Leadville mining district.

Gale, Hoyt S., geologic aid, will assist Ar-

thur Keith in completion of survey of Cowee and Pisgah quadrangles, North Carolina, and in a reconnaissance of adjacent quadrangles.

Gilbert, G. K., geologist, will carry on investigations in glaciology in the high Sierras of California.

Girty, Dr. George H., assistant geologist, will be occupied the greater portion of the season with office work on collections now in hand. Will spend a part of the season in continuation of field work on the Waverly problem in Ohio.

Griswold, W. T., topographer, under supervision of M. R. Campbell, will study structure and stratigraphy of Steubenville and Wellsville quadrangles, Ohio-West Virginia, and of St. Clair quadrangle, Ohio, with special reference to location of oil and gas pools.

Hague, Arnold, geologist, will be occupied with the completion of his monograph on the geology of the Yellowstone National Park.

Hatcher, Dr. J. B., field assistant, will assist Dr. T. W. Stanton in study of non-marine Mesozoic formations of northern Montana.

Haworth, Professor Erasmus, assistant geologist, will be associated with Dr. George I. Adams in areal and economic survey of Iola thirty-minute quadrangle, Kansas.

Hayes, Dr. C. W., geologist in charge of geology, will continue administration of Division of Geology and Paleontology, and will have supervision of investigations in nonmetalliferous economic minerals.

Hess, Frank L., field assistant, will assist Arthur J. Collier in study of gold placers of Seward Peninsula, Alaska. Also in areal mapping and stratigraphic studies in the same region under supervision of Alfred H. Brooks.

Hollick, Dr. Arthur, assistant geologist, will visit a number of localities on the Yukon River, Alaska, for the purpose of making detailed stratigraphic studies and paleontologic collections, under supervision of A. H. Brooks.

Howe, Ernest, assistant geologist, will assist Dr. Whitman Cross in investigation of areal geology of San Juan district, Colorado.

Jaggar, Dr. T. A., assistant geologist, will be occupied with the completion of reports on the Sturgis-Spearfish folio, North Dakota, and the Bradshaw Mountain folio, Arizona.

Johannsen, Albert, field assistant, will assist Dr. Whitman Cross in investigation of areal geology of San Juan district, Colorado.

Keith, Arthur, geologist, will continue areal and economic work in the southern Appalachian Mountains. His work will consist in completion of surveys of the Cowee and Pisgah quadrangles, North Carolina, and a reconnaissance of adjacent quadrangles.

Kindle, E. M., assistant geologist, will assist Professor H. S. Williams in areal survey of Ithaca thirty-minute quadrangle, New York.

Knowlton, Dr. F. H., paleontologist, will be occupied throughout the year in paleo-botanical work upon collections on hand.

La Forge, Lawrence, assistant geologist, will assist Dr. W. S. Bayley in survey of crystalline rocks of Raritan quadrangle, New Jersey.

Leith, Dr. C. K., assistant geologist, will assist Dr. C. R. Van Hise in preparation of final report on geology of Lake Superior region.

Leverett, Frank, geologist, will continue work on the preparation of a monograph on the Pleistocene formations of the Lower Peninsula of Michigan and adjacent portions of Indiana. Will also survey Ann Arbor thirty-minute quadrangle for folio publication.

Lindgren, Dr. Waldemar, geologist, will make a resurvey of the Cripple Creek district, Colorado, in cooperation with the state, associated with Dr. Ransome.

Martin, Dr. George C., special assistant, will make an economic reconnaissance of Controller Bay coal and oil fields and of a part of coal and oil fields of Cook Inlet region, under supervision of A. H. Brooks. Will prepare Accident-Grantsville, Maryland, geologic folio for publication.

Moffit, F. H., assistant geologist, will make reconnaissance of northeastern part of Seward Peninsula, giving special attention to problems connected with occurrence of placer gold. Will be with topographic party in charge of D. C. Witherspoon, topographer, under supervision of A. H. Brooks.

Paige, Sidney, field assistant, will assist Dr. Arthur Hollick, who will visit a number of localities on the Yukon for the purpose of

making detailed stratigraphic studies and paleontological collections.

Peterson, William, field assistant, will assist Professor R. D. Salisbury in glacial work west of one-hundredth meridian.

Prindle, L. M., special assistant, will make reconnaissance surveys of Fortymile, Birch Creek and Lower Tanana placer gold fields.

Purdue, Professor A. H., field assistant, will assist Dr. George I. Adams in study of north Arkansas lead and zinc district.

Ransome, Dr. F. L., geologist, associated with Dr. Lindgren, will make a resurvey of the Cripple Creek district, Colorado, in cooperation with the state, and will study areal and economic geology of Cœur d'Alene mining district, Idaho.

Russell, Professor I. C., geologist, will make a geologic reconnaissance of western Idaho and central Oregon, in cooperation with Division of Hydrography.

Salisbury, Professor R. D., geologist, will have immediate supervision over glacial work west of one-hundredth meridian.

Schrader, F. C., geologist, will be occupied in completing reports on geology and mineral resources of northern Alaska, and on the geology and mineral resources of Upper Copper River region.

Smith, Dr. George Otis, geologist, will carry on areal and economic work in Maine, in cooperation with State Geological Survey.

Smith, W. N., field assistant, will assist Dr. C. R. Van Hise in preparation of final report on geology of Lake Superior region.

Smith, Dr. W. S. Tangier, assistant geologist, will complete reports on lead and zinc deposits of Joplin, Missouri, and western Kentucky districts, and complete areal field work on pre-Cambrian areas in the Sundance quadrangle, South Dakota.

Spencer, Dr. Arthur C., geologist, will investigate areal and economic geology of Juneau mining district. Later will make reconnaisance of economic geology of Berners Bay and some of the other mining districts of southeastern Alaska.

Spurr, J. E., geologist, will complete economic investigation of Tonopah mining district, Nevada, and will revise economic geology of Silver Peak quadrangle, Nevada.

Stanton, Dr. T. W., chief of section, will make a study of non-marine Mesozoic formations of northern Montana, and later in season will visit various Lower Triassic localities in southeastern Idaho and northern Utah, and Cretaceous outcrops in southern Wyoming; and will have general supervision of investigations in paleontology throughout the United States.

Stone, Ralph W., assistant geologist, under supervision of M. R. Campbell, will continue areal and economic surveys of quadrangles in western Pennsylvania, in cooperation with state.

Stose, George W., editor geologic maps, geologist, will be occupied chiefly in editing geologic maps, but will spend a short field season in completion of areal work on Chambersburg quadrangle, Pennsylvania.

Taff, J. A., geologist, will be occupied with the preparation of reports on Indian Territory coal fields.

Taylor, Frank B., field assistant, will continue preparation of his contribution to Leverett monograph, and will complete his work on Pleistocene geology of Taconic quadrangle.

Ulrich, E. O., assistant geologist, will study the paleontology and stratigraphy of the Ordovician and Silurian of the upper Mississippi Valley, and in connection with various geologic parties elsewhere.

Van Hise, Dr. C. R., chief of section, will continue supervision of investigations in pre-Cambrian and metamorphic geology of United States, and will prepare final report on geology of Lake Superior region.

Vaughan, Dr. T. W., geologist, will continue preparation of monograph on fossil corals of United States.

Ward, Professor Lester F., paleontologist, will continue preparation of series of papers on Mesozoic floras of United States, completing the second paper on the older Potomac, the Shasta, the Kootanie and Trinity, and taking up the Middle Cretaceous.

Weed, W. H., geologist, will be occupied with completion of report on economic geology

of Butte mining district, Montana, and will continue field work in investigation of copper deposits in Appalachian region.

White, David, geologist, will continue investigation on paleobotany of the Pottsville and higher Coal Measures in the Appalachian field and will make reconnaissance examination of paleobotany of northern Texas coal field.

Williams, Professor H. S., geologist and paleontologist, will make areal survey of Ithaca thirty-minute quadrangle, New York, and continue studies on Devonian paleontology and stratigraphy.

Willis, Bailey, chief of section, has been granted leave of absence for a year, to carry on stratigraphic investigations in China under the Carnegie Institution.

Wolff, Professor John E., assistant geologist, will continue areal surveys in southern Vermont and New Hampshire.

Woolsey, Lester H., assistant geologist, will assist John M. Boutwell in completion of investigation of mining geology of Park City district, Utah, and in reconnaissance of Coalville quadrangle.

Wright, Charles W., field assistant, will assist Dr. Arthur C. Spencer in investigation of areal and economic geology of Juneau mining district, and in reconnaissance of economic geology of Berners Bay and other mining districts of southeastern Alaska.

SCIENTIFIC NOTES AND NEWS.

Sir W. Ramsay has been elected president of the Society of Chemical Industry. The society has decided to meet next year in New York City.

In order to devote his entire time to the work of the newly organized Department of Anthropology and Ethnology in the Louisiana Purchase Exposition, Dr. W J McGee resigned his position in the Bureau of American Ethnology on July 31, and assumed duty as chief of the new department on August 1. The exhibits will include living representative groups of various primitive peoples, an Indian school in regular operation, and sections of archeology, history, etc.

It is proposed to celebrate the seventieth birthday of Professor August Weismann, which will occur on January 17, 1904. The committee has decided to have prepared for that time a portrait bust of Professor Weismann which shall be deposited at the Zoological Institute of the University of Freiburg with appropriate festivities. It invites cooperation in this undertaking, not only from those who owe scientific stimulus to Professor Weismann and have been guided by him into zoological activity, but also from all colleagues who desire to join in honoring Professor Weismann for his work. Contributions may be sent to the Deutsche Bank, Leipzig, for the account of Professor Zur Strassen, who is treasurer. The alphabetical list of all contributors without statement of amount will be printed, and will accompany the bust. The American members of the committee of fifteen are Professor H. H. Wilder, of Smith College, and Professor Henry B. Ward, of the University of Nebraska.

The Worshipful Company of Drapers have contributed £1,000 to assist Professor Karl Pearson in his statistical researches at University College, London, and in the higher work of his department.

Mr. J. Hutchinson, F.R.S., who has recently returned from the study of leprosy in India, was given a complimentary dinner on July 23 by the members of the medical profession to celebrate his seventy-fifth birthday.

Mr. Charles Schuchert will represent the U. S. National Museum at the Vienna International Congress of Geologists. He is at present studying European, Silurian and Devonian rocks.

Mr. Ford A. Carpenter, U. S. Weather Bureau, San Diego, Cal., has sailed for San Quetin, Mexico, where he will spend a month in meteorological and other investigations on the San Piedra Martir, a 12,000 foot plateau in the Baja California peninsula.

The American Geologist states that Dr. C. R. Eastman, of Harvard University, who has been spending his sabbatical year abroad in special paleontological research, has returned

to Europe in company with Dr. Holland, director of the Carnegie Museum, to take up the study of the fossil fishes in the famous Bayet collection, recently acquired by the museum.

M. Baccelli has been elected a corresponding member of the Paris Academy of Sciences in the section of medicine, in the room of the late M. Olier.

At the recent meeting of the Royal Institute of Public Health its Harben medals of 1901 and 1902 were presented to Sir Charles Cameron and Professor W. R. Smith.

The hundredth anniversary of the birth of Ericsson was celebrated on July 31 by the unveiling of a new statue in his honor erected in the Battery, New York City. Addresses were made by Mayor Low and Col. William C. Church, the author of the life of Ericsson. The statue was remodeled by the sculptor, Mr. Jonathan S. Hartley, from his former work, erected in the Battery in 1893.

Subscriptions to the amount of about $450 have been contributed in Great Britain toward the marble statute of von Pettenkofer, which is to be erected at Munich.

General Brialmont, the Belgian military engineer, has died at the age of eighty-two years.

The French Association for the Advancement of Science will begin its thirty-second meeting at Angers on August 4, under the presidency of M. Emile Levasseur, professor of geography and agriculture at Paris.

An International Sanitary Conference is to be held at Paris, beginning on October 10.

The British government has appointed Captain Harry Mackay, a Dundee whaling master, to the command of the *Discovery* relief expedition. Captain Mackay was master of the relief ship *Terra Nova* when employed as a Dundee whaler, and master of Mr. Barclay Walker's Arctic yacht *Eskimo,* now the steamship *America,* in the Zeigler-Polar expedition.

The secretary of the committee of the Bessemer Memorial Fund announces that for the purposes of advanced metallurgical training and specialized research work it is proposed that London shall be regarded as the center for the metallurgy of copper, silver, gold, etc.; Sheffield as the center for steel; and Birmingham as the center for cast and wrought iron and alloys. This decision will not, however, prejudice the claims of other metallurgical centers for participation in the fund. It is also intended that the post-graduate scholarships shall, in part, be international.

A Laffan telegram from Berlin states that during the months of May and June Professors Wolf and Dugan, of the Königstuhl Observatory, near Heidelberg, have by means of long photographic exposure discovered eight little planets, provisionally indicated by 1903, L Q to L X. They vary between the 11th and 14th magnitude.

UNIVERSITY AND EDUCATIONAL NEWS.

Mrs. Hettie F. Ballantyne, of Pittsburgh, has given $20,000 to Allegheny College for the endowment of scholarships.

Syracuse University is to receive one third of the residue of the estate of the late Mrs. Caroline S. Reid.

Mr. J. Martin White, of Dundee, has given to the University of London a sum of £1,000 for the provision of courses of lectures in sociology, including anthropology, social psychology, social philosophy and ethics.

At the University of London Mrs. Bryant, D.Sc., Sir Henry Howse, D.Sc., and Dr. A. D. Waller, F.R.S., have been elected vice-chairmen of the board to promote the extension of university teaching, the committee of the medical members of the senate, and the scientific apparatus committee respectively.

Dr. Karl Wilhelm Genthe, for the last two years instructor in natural history in Trinity College, has been promoted to an assistant professorship in that institution.

Dr. C. B. Waller, assistant professor of mathematics at Clemson College, S. C., has been elected professor of chemistry and biology at Wofford College, Spartanburg, S. C.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 14, 1903.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*TEN YEARS OF AMERICAN PSYCHOLOGY: 1892–1902.**

I.

SOME future historian of our science will have a very interesting opportunity to trace and to describe the characterizing features of the so-called 'modern' psychology, and the alleged discoveries made by its devotees. The name of this science and its titular employment in the writing of books are a little bit younger than the discovery of America. It is, perhaps, both too early and too venturesome to suggest that there might be some mystic connection between that name and that historic event. The habilitation of the lore incorporated under that name as a 'science' began just half a century ago. Lotze's 'Medicinische Psychologie' appeared in 1852, and that year must be regarded as the beginning of the new psychological calendar. Some twenty years later Wundt's 'Grundzüge der Physiologische Psychologie' appeared (1874), and about a quarter of a century passed before the first distinct experimental institute for the psychologist had its beginning at Leipzig (1878). After thirty years America had its first laboratory

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(1883). The end of the fourth decennium permits us to see the organization of our association. And the close of the fifth finds us here and now—in full psychological array, shall we say? To the chronicler, at least, the decennia accentuate themselves by reason of the paramount importance of the events which have brought us together.

Our hoped-for historian will probably find himself in a position to point out the importance of these fifty years as residing in their revolutionary results in defining the conception and the method of psychology. Prior to this era, psychology was well regarded as a waif; it was not received by the students of facts, and it was gingerly given a berth by the great chasers after world categories. The revolution which has given us a 'scientific' psychology, the historian will have to say, proceeded in two directions. First, it developed a general type of method, which wrought the great change from a speculative defense of the application of certain theoretical interpretations of every variety of inner experience, to a factual, inductive, measurable, experimental mode of approach to that same experience. The central significance of this change is amply seen in the contrast presented by the fact that modern psychology finds its object is constant with that inner experience—the soul of man remaining the same, so we may assume—but the conclusions of the study of it—how different from the conclusions of any era which has preceded! No less has its influence been exerted in the direction of creating essentially new problems concerning the behavior of mind. Second, it has introduced a basal conception which has shifted from the individualistic, or substantial view of the system builder, to that of the functional, phenomenal view of cosmic evolution, irrespective of the particular formulation given to that idea. Instead of continuing to regard mind as a point of persistent regard with the old psychology, the 'new' has demanded that the 'process' interpretation shall alone be considered fruitful. The revolution in psychological method arose and flourished in Germany; that in conception is the contribution largely of English thinking, which took its definite shape about 1855. The flowering of the former has given us 'experimental' psychology; of the latter, 'genetic' psychology. Such, it seems to me, must be looked upon as the polarization of the psychological thinking which it is given to us to perpetuate or radically to modify.

It may seem to be a piece of venturesome youthfulness and daring jingoism to speak of 'American' psychology, and to define for a science precise boundaries both in space and in time. That this is but a superficial impression is to be seen readily from our desire to emphasize the domestication of the term 'psychology' within our national borders, which has practically—not essentially—occurred within the time limit of the decennium just ended. In the past, American psychology sailed under the terms of 'mental and moral philosophy,' which have even now some fixed and secure anchorages. It, too, was molded chiefly by the theologians, whose line of intellectual descent runs back almost without break to Scottish realism. The good thing in this step-motherly care over psychology consisted in the wholesome fact that that form of speculation attributed a rather definable degree of primacy and reality to human consciousness, which are so fundamental to the genuine psychological attitude. And that was about the only good thing in this theological fostering. That one may venture to speak of an 'American' psychology is to be regarded as a recognition of an undoubted

effort on this side of the Atlantic to renounce our former mode of intellectual dependence upon some foreign system, or upon some old-world thinker. At the same time, no one can be more ready than ourselves loudly to decry jingoism in science. For science, happily, knows no nationality. It is the common heritage, in sharing which no form of social prejudice can despoil us. It is fully possible, however, for the development of a science within a national border to give a definite contribution to the type of life therein growing, and especially is this a hopeful probability the nearer the science approaches the needs of a complete science of man.

The chief justification for our speaking of American psychology is to be found in the fact that our association is just ten years old, and resides in the desire to contribute modestly to the celebration of the decennium by passing in review the work of the association and its influences upon the situation of psychology presented in the United States. Accept the name of our organization, and the adjective in our theme follows as an appropriate sequence. Moreover, it ought to be a good tonic to insist on the value of psychology accruing through the use of the adjective marking nationality.

Inasmuch as the appearance of the American Psychological Association was not a Minerva-like birth, it is proper that a glance should be given to the stock in trade possessed by psychology ten years ago. The state of the science during the decennium preceding the one under review was very satisfactory and encouraging. The gradual influx of its European developments into American thinking took form in a number of definite achievements, which rapidly multiplied in the years to follow. The perfection of exact methods, the adaptation of instruments to test reactions of the simpler order, and the close correlation between the data of cerebral physiology and well-established groups of mental phenomena, tended at first to bring psychological advances into disrepute among those outside its own domain who might have a care for its fortunes, and to gain for these results, in the mouths of theologians and other convenient idealists, the opprobrious epithet of 'materialistic.' The helpfulness of man's self-study for his own development was dangerously neglected in these criticisms, and even the pittance of a culture value to the pursuit of this subject was barely allowed to its chief defenders.

Nevertheless, the decade brought forth noteworthy achievements, both in American scholarship and in American educational institutions. The first American attempt at exact psychological demonstration probably occurred at Harvard in our centennial year. The first laboratory for psychology in America was opened in 1883 by President G. Stanley Hall, as professor of psychology and pedagogy in the Johns Hopkins University. The same year witnessed sporadic efforts here and there to study and to teach something of physiological psychology. The waning of the old and the dawning of the new modes of psychologizing were interestingly marked in three books which appeared in 1886 and 1887: McCosh's 'Psychology: The Cognitive Powers,' Bowne's 'Introduction to Psychological Theory' and Dewey's 'Psychology.' The first tried in a well-intentioned way, at least, to realize the shifting of the center of psychology; the second fought the one-sided materialistic issues of forty years earlier; and the third seriously welded the newer facts of science into the system of absolutism and made psychology a museum of well-balanced definitions. These

imperfect or combative tendencies practically came to their American end in the year 1887, when the *American Journal of Psychology* was founded by President Hall, and Professor George Trumbull Ladd published his 'Elements of Physiological Psychology.' This was the first book to present a careful, synthetic statement of psycho-physical facts in the English language. Through the double reason of their priority in time and their scientific saneness, these two foundations have had the most influence upon the tenor of later American psychology: the one by its emphasis upon research, the other for the academic presentation of the new subject and interpretations of the higher manifestations of mind. For the virtues of a science are largely to be sought in the two directions of original investigation and adequate teaching. The following year, 1888, witnessed the establishment of the first American chair for psychology alone with a laboratory at the University of Pennsylvania, with Professor J. McKeen Cattell in the chair. Here, also, I believe, was given the first instruction in experimental psychology to undergraduate students. Our stock in trade was increased in the two years following by the appearance of Professor J. Mark Baldwin's 'Handbook of Psychology' (first part, 1889), and Professor William James's long-awaited 'The Principles of Psychology' (1890). Here at last came a mighty reinforcement to the psychological impetus, which had been dealing so long in 'first things,' and whose momentum was growing so rapidly; and here came also that added rich flavor which has placed American psychology upon the high pedestal of literary expression, and made it most palatable to the popular mind, while being descriptively in close accord with the facts.

In 1891, our esteemed president began the publication of his splendidly organized and selected work, 'A Laboratory Course in Physiological Psychology.' This second great American step in the adoption of a pedagogical method was sure to be taken, and thus early did a pioneer selective teacher enable the transformed science to take its accredited position among university studies.

In these varied ways of laboratories, chairs and systematic literature, American psychology took on a splendid and resistless form of organization in the universities and colleges, whence radiated the multiple specialties which were developed by those who followed the leadership of these agencies in our higher education. An additional item taken from a more popular gauge of psychological values offers a fitting opportunity to make the contrasts between the psychology that had been and the psychology that was soon to be. The National Educational Association of the United States, at its Toronto meeting in 1891, gave a pinch of attention to experimental psychology. Two round tables, presided over by President Hall, were permitted, but not recognized as a part of the work of the association. The American policy of indebting itself to the Old World continued during these years in the usual double fashion of sending our students abroad for psychological specialization and by bringing in translations of foreign literature. This double mode of our enrichment has placed a blanket mortgage, I fear, upon the stability of the confidence of the American academic administrators in the resources of our own institutions. Certain additional features in the situation ten years ago may be reserved for more fitting mention later.

TEN YEARS INSIDE THE ASSOCIATION.

The increasing objectivity of psychology in America was augmented by the organization of our association in 1892. When the *American Journal of Psychology* moved to the 'Heart of the Commonwealth' of Massachusetts, its editor found himself near the center of things psychological, at least in New England. In the hope of conserving the great gains which had been made for the science, and with the desire of having an exchange where psychological efforts might be pooled and where a more personal and direct mode of checking off results might be available than through the existing channels of publication, President Hall nursed the idea of a society of psychologists, and took counsel by pen and by mouth with many workers in this field. Everybody consulted was in sympathy with the idea, and wanted to become a member of whatever organization might be effected, pledging his hearty cooperation. Fortified and clarified by these preliminaries, including a conference of some length with Professor Ladd, he issued a letter of invitation to more than a score of psychologists to meet at Clark University, on July 8, 1892. A company of men gathered at the appointed time and place, and the preliminary meeting was held, six papers being presented and discussed, and plans projected for a permanent organization. The first annual meeting was held on the 27th and 28th of the December following, at the University of Pennsylvania. Annual meetings have been held in the meantime. The following table presents a summary statement of the features of these meetings, detailing for purposes of ready comparison the items of place, president, election to membership, total membership, attendance of members at each meeting, papers, reports and discussions presented, the number of contributing members and readers not members, research grants, and the treasury balances.*

It is interesting to note that most of the organizing psychologists were interested in the project for the sake of fellowship, friendship and the enjoyment of personality. In reviewing the history of the association, and in attempting to ascertain just what it may have done for its object of advancing the science, we can not simply regard it as a social club, meeting for jolly good times. On the contrary, we must look to the work it has actually accomplished or stimulated and recognized. The annual notice of its meetings sent to its members calls for the title of papers to be read. And to this type of activity our attention must primarily be directed.

I therefore adopted the plan of classifying topically the varied material which has been brought in and given a place at the several meetings, in the form of papers, set discussions and research reports, in order to gather up, in a summary fashion, the actual cooperative achievements within the association. The value of such a summary doubtless depends upon the comprehensiveness of the rubrics selected as representing

* The data are compiled from the reports of the meetings to be found as follows:

'Proceedings of the American Psychological Association.' Macmillan and Co., New York (no date), pp. 29. (Contains accounts of the Preliminary, the First Annual, 1892, and the Second Annual, 1893, meetings.) Third Annual meeting, 1894, in *Psychological Review*, II., 1895, pp. 149–172. Fourth Annual meeting, 1895, in *Psychological Review*, III., 1896, pp. 121–133. Fifth Annual meeting, 1896, in *Psychological Review*, IV., 1897, pp. 107–141. Sixth Annual meeting, 1897, in *Psychological Review*, V., 1898, pp. 145–171. Seventh Annual meeting, 1898, in *Psychological Review*, VI., 1899, pp. 146–179. Eighth Annual meeting, 1899, in *Psychological Review*, VII., 1900, pp. 125–158. Ninth Annual meeting, 1900, in *Psychological Review*, VIII., 1901, pp. 158–186. Tenth Annual meeting, 1901, in *Psychological Review*, IX., 1902, pp. 134–155.

the psychological field. Each psychologist probably has his own pet or changing scheme for dividing the great typical departments of the science as they may appeal to him. I have sought to avoid, in the first instance, such a limitation by following the revised rubrics of 'The Psychological Index,' introduced in 1900, which may be regarded as the latest and perhaps the best existing scheme of division covering that part of the field of psychology which reaches the stage of print. It groups psychological literature under ten chief heads, which are so divided and subdivided as to provide a list of eighty-eight different topics. The following classification of the material available is therefore based on those rubrics. The table includes the presidential addresses and papers presented by title only, but omits the material presented by six persons at the preliminary meeting in 1892 and the general discussions which may have followed any papers.

Table I. General Summary of the Meetings of the American Psychological Association.

Meetings.	Preliminary.	First.	Second.	Third.	Fourth	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.
Date.	July 8, 1892.	Dec. 1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
Place.	Clark Univ.	Univ. of Penn.	Columbia Coll.	Princeton Univ.	Univ. of Penn.	Harvard Univ.	Cornell Univ.	Columbia Univ.	Yale Univ.	Johns Hopkins Univ.	Univ. of Chicago.
President.		G. S. Hall.	G. T. Ladd.	W. James.	J. McK. Cattell.	G. S. Fullerton.	J. M. Baldwin.	H. Münsterberg.	J. Dewey.	J. Jastrow	J. Royce.
Election to membership.	5	11	14	11	11	16	15	13	16	4	7
Total membership.	26	31	42	56	67	78	94	109	122	138	142
Attendance.		18	33	22	23	45	38	51	56	30	30
Papers, etc., presented.	(6)	21	21	24	19	23	37	41	52	25	20
Contributing members.	(6)	10	14	17	17	19	21	26	40	22	18
Non-members contributing.		1		1	1	2		1	1	2	2
Research grants.							$100.00		$50.00		
Treasury balances.		$50.30	$69.50	$127.17	$284.29	$473.54	$669.10	$800.18	$1,097.88	$1,222.53	$1,524.46

In preparing such a classification of an enormously varied material, it must be readily confessed that extreme difficulty was often met in deciding the topical properties of a given communication or report. In making the statistical distribution, I have had a special care to represent the themes as faithfully as possible. Special comment must also be made concerning the statistical unit employed in gathering the summary. Such a mode of classification must be based on the equivocal unit derived by making each paper, report or address in a set discussion stand as an integer, becoming the unitary equivalent of every other paper, report or discussion. The amount of psychological material, the expenditure of labor required in its preparation, and the comparative and the net values of its results, either as research or as criticism, represented in this arbitrary unit are completely lost sight of in such a scheme. This is unavoidable. What the table truly represents is the number of times the given psychological topics have been more or less within the focus of the association's attention, and the distribution of these topics throughout the whole field of psychological investigation.

Accepting this mode of bunching the work of the ten years, our table offers the following summary. The annual meetings have called forth fifty-six papers on general topics, seven on the nervous system, fifty-three on sensation, thirteen on the characters of consciousness, thirty-four on cognition, two on affection (pleasure and pain being grouped under sensation), seventeen on conation and movement, thirty-nine on the higher manifestations of mind, ten on sleep, trance and pathology, forty-

Table II. Classification of Communications Received by the American Psychological Association, 1892–1902.

Rubrics of the *Psychological Index.*	1	2	3	4	5	6	7	8	9	10	Tot.	%'s
I. General											56	20—
1. Text-Books and Systematic Treatises												
2. General Problems, Methods, Terms and Apparatus	6	5	4	1	3	4	7	11	5	1	47	
3. History and Biography	1			1	1	2		1	3		9	
4. Collections, Proceedings, Dictionaries and Bibliographies												
II. Anatomy and Physiology of the Nervous System											7	3—
1. General												
2. Nerve Elements												
3. Brain and its Functions												
a. Anatomy of the Brain												
b. Physiology of the Brain					1	1	1		1		4	
4. Spinal Cord, Nerves and Sympathetic System												
5. Reflex and Automatic Functions				1		1	1				3	
6. Pathological Anatomy												
III. Sensation											53	19—
1. General; Synæsthesia					1	1	1	1			4	
2. Sense Organs (General)												
3. Psycho-physics (Weber's Law, etc.)	1				1	3	1				6	
4. Psychometry	3	2	1								6	
5. Vision and Ocular Motor Functions												
a. General												
b. Anatomy and General Physiology of the Eye												
c. Physics and Special Physiology of Vision			1			2	3	1			7	
d. Visual Sensations			1	1							2	
e. After-Images, Contrast, etc		2				1	1				4	
f. Eye Movements and Binocular Vision								3	1		4	
g. General Pathology of Vision												
6. Hearing												
a. General												
b. Anatomy of the Ear												
c. Physics and Physiology of Hearing												
d. Auditory Sensations								1		1	2	
e. General Pathology of Hearing												
7. Other Senses												
a. Taste and Smell			1				1				2	
b. Cutaneous, Pressure and Joint	2	1			1	1					5	
c. Muscle Sense and Muscles		1	1								2	
d. Static Sense, Position, Equilibrium, Dizziness												
e. General Sensibility, Organic Pleasure and Pain Senses	1	2	5				1				9	
8. General Pathology of Sensation												
IV. Characters of Consciousness											13	4+
1. General								1			1	
2. Attention, Apperception, Selection						1	1			1	3	
3. Association												
4. Habit, Accommodation, Adaptation						3					3	
5. Work and Fatigue	1					1		1		1	4	
6. Time Relations of Consciousness				1						1	2	
V. Cognition											34	12+
1. General			1				1				2	
2. Perception and Idea; Reading		1		1		1				1	4	
3. Perception of Time, Space and Motion		1				1			1		3	
4. Memory and Imagination	1	1	1		1		1			1	6	
5. Judgment and Belief; Reasoning	1					1	4			1	7	
6. Reflection and Self-Consciousness			1		1	1	1		1		5	
7. Normal Illusions and Normal Suggestion	1		1	1		2	1			1	7	
8. General Pathology of Cognition												
VI. Affection (Feeling and Emotion)											2	1—
1. General; Pleasantness and Unpleasantness												
2. Emotion and its Expression			1						1		2	
3. General Pathology and Feeling												
VII. Conation and Movement											17	6+
1. General; Dynamogenesis and Inhibition								1			1	
2. Organs of Movement												
3. Instinct and Impulse (Imitation, Play, etc.)			1				2				3	
4. Special Motor Functions												
a. Language and Song							1	2			3	
b. Handwriting and Drawing									1		1	
c. Walking												
d. Other Motor Functions							1	2		1	4	
5. Volition and Effort				1				1	1		3	
6. Freedom of the Will			1					1			2	
7. General Motor Pathology												
VIII. Higher Manifestations of Mind											59	14—
1. Logic and Science; Methodology				1	3			2	3	2	11	
2. Ideals and Values												
3. Theory of Knowledge					1	1		4	1	1	8	
4. Æsthetics	1						1	1		1	4	
5. Ethics					2		3	2	2	1	10	
6. Religion						1		3		2	6	
IX. Sleep, Trance and Pathology											10	3+
1. Sleep and Dreams	1	1		2		2					6	
2. Hypnosis and Trance States												
3. Psychical Research												
4. Pathology; General Discussion									1		1	

TABLE II. CLASSIFICATION OF COMMUNICATIONS RECEIVED BY THE AMERICAN PSYCHOLOGICAL ASSOCIATION, 1892–1902.—*Continued.*

Rubrics of the *Psychological Index.*	1	2	3	4	5	6	7	8	9	10	Tot.	%'s
5. Nervous Diseases												
a. General						1					1	
b. Neurasthenia and General Paralysis												
c. Epilepsy and Hysteria												
d. Other Neuroses												
6. Mental Disease												
a. General (Insanity)												
b. Idiocy, Imbecility, etc.												
c. Other Special Psychoses					1		1				2	
7. Medical Jurisprudence												
X. Genetic, Individual and Social Psychology											**41**	14+
1. Evolution and Heredity		1			1	1				1	4	
2. Comparative Psychology			1	1	1		1	1	1	1	7	
3. Mental Development				6			1				7	
a. General; Adolescence and Senescence												
b. Child Psychology		1			1			2			4	
c. Pedagogy							2	5			7	
4. Individual, Sex and Class Psychology		1	2	1				5	2		11	
5. Folk Psychology												
6. Social Psychology												
7. Race Psychology					1						1	
a. Criminology												
b. Degeneration												
Physical and Mental Test Reports (not included above)	1	1			2	4	2			1	**11**	4—
Totals	21	21	24	19	23	37	41	52	25	20	283	100

one on genetic, individual and social psychology and eleven reports on physical and mental tests, making an aggregate of two hundred and eighty-three communications the association has received. Thirty-eight of the eighty-eight topics listed by 'The Psychological Index' have remained barren throughout the ten years, not having received a single notice. They comprise almost one half of the whole field so listed, showing a rather surprising lack of breadth of treatment. It should be observed, however, that these topics are largely pathological in scope. It is unnecessary here to recount these special topics, which are readily traced in the table.

If one wishes to ascertain the points emphasized in the work of the association thus represented, and learn what have been the lines of dominant interest expressing themselves, he may take numbers as indicative thereof. Arranged in the order beginning with the maximum and ending with the minimum, the summary shows the following results, of course presupposing that all the material has been of a distinctly psychological character: General (56), sensation (53), genetic, social and individual psychology (41), higher manifestation of mind (39), cognition (34), conation and movement (17), characters of consciousness (13), mental tests (11), sleep, trance and pathology (10), anatomy and physiology of the nervous system (7), affection (2).

This topical arrangement offers only the advantages of a cross-section view of the ten years, and is, therefore, inadequate to point out the more interesting perspective of the drifts and tendencies which may be taken to mark the ups and downs of interest in so far as they may have been evoked by the association. I have, therefore, redistributed the material under such rubrics as, it seems to me, more adequately point out the methods, types of interest, and perhaps results, which are what we chiefly seek in the historical way. The selection of the headings employed in Table III., such as 'historical,' 'theoretical,' 'descriptive,' 'experimental,' etc., must be left to justify itself. It need scarcely be added that in the preparation of this table, as was the case in the preceding table, recurring difficulty was encountered in tabbing off a paper under this topic, or under

that; but the sanity of the distribution may safely be left to him who is ready to wade through the material for himself. The possible modification of the results thus obtained through the qualities of our arbitrary unit must also not be overlooked.

edly philosophical. The last two meetings indicate a noticeable diminution of interest and activity in all these directions, except possibly that of the philosophical group. Only two meetings, the seventh and the eighth, have brought forth something in

Table III.

Type of Communication.	(At the preliminary meeting six members presented papers, of which there are no details.)	First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.	Totals.	Percentages.
Historical		1			1		2	1	3	3	1	12	4+
Theoretical			4	6	2	2	2	1	6	1	1	25	9—
Descriptive			2	1	1	1	2	9	4	1	2	23	8+
Experimental		12	9	8	6	5	17	11	10	4	4	86	30+
Comparative				1	1	1		1	1	1	1	7	3—
Genetic			2	2	6	1	1	4	5	1	3	25	9—
Pieces of apparatus shown or described		1	2	3		1	3	6	7	4	1	28	10—
Physical and physiological		5	1	2	1	1	4	3	1	2		20	7+
Pedagogy and the application of psychology				1		2	2	1	5		1	12	4+
Philosophical		1			1	8	2	2	8	7	5	34	12+
Discussions with the naturalists						1	1	1	1			4	1+
Miscellaneous		1	1	(5)*			1	1	1	1	1	7	3—
Totals		21	21	24	19	23	37	41	52	25	20	283	
Percentages		7+	7+	8+	7—	8+	14—	15—	18+	9—	7+		100

* Five papers were offered, but not read, nor mentioned by title.

Resorting again to a statistical indication of the type of psychologizing developed under the sponsorship of the association, we find this summary presenting the following scale of interests. In ten years the association has countenanced eighty-six items of an experimental character, thirty-four philosophical, twenty-eight on apparatus, twenty-five theoretical, twenty-five genetic, twenty-three descriptive, twenty physical and physiological, twelve historical, twelve pedagogical, seven comparative, seven miscellaneous and four discussions outside. A detailed study of this table shows some interesting contrasts, which the reader can not fail to detect. Attention may be called to some of them. The first, sixth, second, third, seventh and eighth meetings have been predominantly experimental in the order named. The fifth and ninth meetings have been mark-

every direction. The pedagogical interests of the science have had the smallest distribution, having been in evidence at only six meetings. In spite of the apparently shifting interests, the association may claim for itself a scientific and inductive character. Forty per cent. of the material belongs to the experimental and apparatus items alone. And more than eleven per cent. properly contributes to the developmental point of view.

Not to undertake a discussion of the contributive values of the papers to the growth of the science is a restriction we have placed upon this historical survey, and the relative merits of the contributions made under each heading we refrain from discussing, except the one instance of the presidential addresses, to which we now turn.

THE PRESIDENTIAL ADDRESSES.

The ten presidential addresses delivered before the association, which have been included as so many units in the general summaries above, are interesting enough for separate note. These reviews and discussions of our psychological nestors may well be regarded—at least be expected to be so—as indicating the high-water mark reached by the psychological tides in the ebb and flow of the years. They are, in truth, made up of congratulations, instructions and warnings to psychology. There have been ten of them; hence their mere numerical evaluation can count for but little. Four men, Presidents Hall, Ladd, Cattell and Jastrow, have reviewed the history, progress, present position and the prospects of psychology; while six, Presidents James, Fullerton, Baldwin, Münsterberg, Dewey and Royce, have specialized in the problems they presented. Four of the latter, oddly enough, have allowed their presidential thoughts to center around certain cognitive problems of the intellect. One address was expressly devoted to the ontological differentiations between 'Psychology and History.' And, finally, only one address of the ten attempted *in extenso* to make good the claim that psychology has manifest and manifold practical applications, which occurred under terms of 'Psychology and Social Practice,' the special form of social practice considered being education.

It is not a little interesting to see how hard it is for the psychologists *von Fach* to keep from trespassing on the green fields of epistemology and metaphysics. The borderland between the scientific and the speculative interests has not only been wandered over, but there have been technical discussions of the latter. This appears unquestionably in such themes as 'The Knowing of Things Together,' 'The Self in its Function of Knower,' 'Recent Logical Inquiries and their Psychological Bearings.' Six presidents dwelt upon the relation between psychology and philosophy, some at length, but all approvingly, including one who has stood most stoutly and clearly for the development of exact, quantitative results in the laboratory. Thus the majority have either affirmed in general or illustratively detailed the interdependent relation between this new science and the old love of reason.

It is disappointing to discover in the scope of these addresses that only three presidents have dealt with the laboratory field of problems, the scope and the conditions of the psychological experiment and the relations of statistical and experimental studies of mind to the total science of psychology. Not even the experimentalist presidents—professionally such, of whom there have been at least three, and at most six—have improved the presidential occasion for giving greater momentum and needed clarity to the experimental development of the science. Where prejudice against the method might have been supposed to exist there has been the greater generosity in recognizing it; and where passion for the method should have existed, there has been actual default in the use made of the opportunity.

One half of the presidents have treated of purely formal, theoretical or speculative interests. Two have supported the genetic method and attempted to vindicate the bearing of the conception of evolution on the problems, methods and attitudes of psychology. Only one has suggested the psychological values of abnormal and decadent experience, while none has dealt with the feelings.

Six presidents have been content to look backwards, or to feel certain only up to the present; while not more than four have looked forward and suggested new prob-

lems or other constructive work which would tend to strengthen the science among the sciences and in the esteem of those who mold our educational and national life. The practical aspects of our science, its values in the conduct of life and its direct bearings in education, medicine, treatment of the unfortunates and in social reforms, its influence upon the development of other sciences, such as biology, anthropology, sociology, logic and ethics, and its aid in the pursuit of art, history and literature, have been clearly affirmed by five presidents, denied by one, and practically ignored by the rest. Only one, I believe, has seriously touched the question of the teaching of psychology to our student body. Which type of a president derived by compositing all these contrasts is the more desirable and the more useful in our leadership in view of the present needs of psychology, is a query that must be referred to each one by himself.

THE MEMBERSHIP.

The structure of an association organized in the interest of the advancement of science finds its efficiency not so much in the cortical officials who annually declare their views, as in the interest and efforts of its members, who actively explore the psychological field, offer intelligent criticism of past returns, and otherwise increase its content of fact and in general advance its repute. The scientific and professional aims of the association have been safeguarded within itself, at least, by that modern form of predestination which makes the psychologist's 'calling and election sure.' We have already given an impersonal summary of the work yielded by the elect. We have yet to consider its distribution among the individuals. The fourth, fifth, sixth, seventh and eighth headings in Table I. present the aggregate facts to be considered in detail.

Beginning with twenty-six original members, the association has grown annually, having admitted in the ten years one hundred and forty men and eight women to membership. One man has been elected twice to membership, and seven of the women abide with us still. The present roll includes one hundred and twenty-seven names, showing a total loss, by death and voluntary cessation, of twenty-one members during the ten years. In the matter of attendance, the showing is not as satisfactory as one would wish for the efficiency of the association. The average attendance of members at each meeting has been nearly thirty-five, which is but slightly above the membership at the first annual meeting. Reasons geographical and financial, not to mention others more temporary or personal, must not be overlooked in interpreting for psychology's fellowship, the percentage the attendance at each meeting has been of the total elections indicated above. It is, however, in place to ask, why has the association apparently lost its hold upon our psychological nestors, who have seemed ready to give place to the younger men? This may indicate a lack of interest on their part in the scientific details that legitimately find place in the proceedings, or it may betoken a change in the community of interest in the unified development of inquiry and criticism. Psychologists above all others are least apt to misinterpret the significance of mere numbers, popularity or enthusiasm. But those who wield greater influence in shaping the association's affairs can well take into consideration the causes of the lessening grip upon many of the more mature and industrious of our coworkers, and seek to promote the faith within ourselves.

The most noticeable feature in the comparative exhibit in Table I. is the contrast

between the steady increase in membership and the absence of any marked deviation in the number of members who have contributed to the material of the association, excepting at the eighth annual meeting. This is all the more striking in view of the fact that the association receives communications 'by title,' and these are relatively few in number. The average attendance at the annual meetings is almost thirty-five. The average number annually elected to membership is almost twelve. But the average number of contributing members is only about twenty, a number which remains well-nigh constant.

A more forceful, and thus a more interesting, way of showing the aggregate individual distribution of the industry that has found place among us annually is given in the following summary, which includes two or three instances of joint authorship. Eighty-nine members have been the total contributors, of whom thirty-four have presented one unit, as paper, report, etc., each; twenty-three have presented two units each; ten have presented three each; eight have presented four each; five have presented five each; three have presented six each; two have presented seven each; one member has presented fourteen, one seventeen, one nineteen and one twenty-three units.

The remaining fifty-nine members have been inactive, *silently* paying their annual dues. It is, indeed, a serious question whether the association can hasten its realizations by carrying forty per cent. empty baggage, or whether this phase of the situation should not be radically changed. Almost twenty-six per cent. of the total contributions offered has been the work of four members, who are laboratory men. It will not be overlooked that they have simply stood as sponsors mostly for the work done by the student body of researchers working under their direction. No one would, of course, give an unequivocal sanction to much speaking as a psychological test. But such a summary shows the lines of inevitable fruitfulness.

Again the inevitable query bears in upon us: What of the value of the material which has been thus variously presented from time to time? But we must continue to set it aside. If one attempts to judge its worth, and the advance of science through its worth, he runs into the danger of maintaining that the field over which we have trod remains *sub judice*. And, moreover, it might reveal an immodest immaturity, to say the least, should one attempt to anticipate our psychological posterity in its function of judging of the offerings which have been brought hither year by year.

There is one function which the association can properly undertake more seriously, which would tend to secure a steady advance in the value of the newer material psychological researches may bring forth. At present the indefinite and uncertain method of 'natural selection' or mere survival of interest in individual cases is the only mode of checking off results. An improvement over this method would be a planful arrangement whereby the association could see to it that the annual output of new conclusions and formulæ is intelligently and critically evaluated. This would effect a great saving of individual labor on the part of each psychologist.

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(To be continued.)

PROFESSOR ALEXANDER GRAHAM BELL ON KITE-CONSTRUCTION.

IT is fortunate for those interested in aeronautics and the exploration of the air

that Professor Alexander Graham Bell has joined the band of experimenters and is lending his inventive genius to the cause. Professor Bell has been for several years experimenting with kites, led to this line of experiments, he thinks, because of the intimate connection of the subject with the problem of the flying machine.* Professor Bell began his experiments with the box-kite of Hargrave, whom he recognizes as the pioneer in modern kite-construction. His objections to the box-kite are that, "It requires additions to the framework of various sorts to give it sufficient strength to hold the aeroplane surfaces in their proper relations and prevent distortions of the kite-frame under the action of the wind. Unfortunately the additions required to give rigidity to the framework all detract from the efficiency of the kite: first, by rendering the kite heavier, so that the ratio of weight to surface is increased; and, secondly, by increasing the head-resistance of the kite. A rectangular cell like *A* (Fig. 1)† is structurally weak, as can readily be demonstrated by the little force required to distort it into the form shown at *B*. In order to remedy this weakness, internal bracing is advisable of the character shown at *C*. This internal bracing, even if made of the finest wire, so as to be insignificant in weight, all comes in the way of the wind, increasing the head-resistance without counterbalancing advantages."

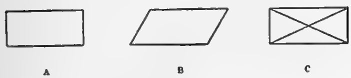

FIG. 1.

These remarks of Professor Bell concerning guys, etc., do not apply to the original Hargrave kites which have no guys, but only to a style of Hargrave kite invented and patented by me. This style is the one which has come into universal use under the name of the Hargrave kite, and is the one with which Professor Bell began his experiments rather than with the original Hargrave structure, few of which have been made.

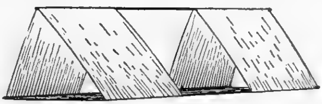

FIG. 2.

Continuing, Professor Bell says: "In looking back over the line of experiments in my own laboratory I recognize that the adoption of a triangular cell was a step in advance, constituting indeed one of the milestones of progress, one of the points that stand out clearly against the hazy background of multitudinous details. The following (Fig. 2) is a drawing of a typical, triangular-celled kite, made upon the same model as the Hargrave box kite. * * * A triangle is by its very structure perfectly braced in its own plane, and in a triangular-celled kite, like that shown in Fig. 2, internal bracing of any kind is unnecessary to prevent distortion of a kind analogous to that referred to above in the case of the Hargrave rectangular cell (Fig. 1). The lifting power of such a triangular cell is probably less than that

* His experiments are described in a communication made to the National Academy of Sciences, in Washington, D. C., April 23, 1903. Also *National Geographical Magazine* for June, 1903.

† The numbers of the figures differ from the original because many of the figures are omitted here.

of a rectangular cell, but the enormous gain in structural strength, together with the reduction of head-resistance and weight due to the omission of internal bracing, counterbalances any possible deficiency in this respect.''*

''Triangular cells also are admirably adapted for combination into a compound structure, in which the aeroplane surfaces do not interfere with one another. For example, three triangular-celled kites, tied together at the corners, form a compound

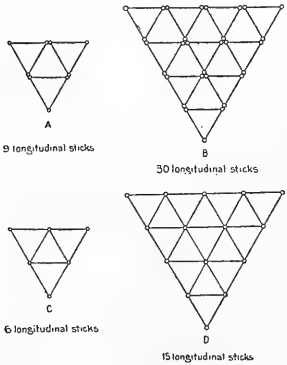

Fig. 3.

cellular kite (Fig. 3, *A*) which flies perfectly well. The weight of the compound kite is the sum of the weights of the three kites of which it is composed, and the total aeroplane surface is the sum of the surfaces of the three kites. The ratio of weight to surface, therefore, is the same in the larger compound kite as in the smaller constituent kites, considered individually.

''It is obvious that in compound kites of this character the doubling of the longitudinal sticks where the corners of adjoining kites come together is an unnecessary feature of the combination, for it is easy to construct the compound kite so that one longitudinal stick shall be substituted for the duplicate sticks. For example: the compound kites *A* and *B* (Fig. 3) may be constructed, as shown at *C* and *D*, with advantage, for the weight of the compound kite is thus reduced without loss of structural strength. In this case, the weight of the compound kite is *less* than the sum of the weight of the component kites, while the surface remains the same. If kites could only be successfully compounded in this way indefinitely, we should have the curious result that the ratio of weight to surface would diminish with each increase in the size of the compound kite. Unfortunately, however, the conditions of stable flight demand a considerable space between the front and rear sets of cells; and, if we increase the diameter of our compound structure without increasing the length of this space, we injure the flying qualities of our kite. But every increase of this space in the fore and aft direction involves a corresponding increase in the length of the empty framework required to span it, thus adding dead load to the kite and increasing the ratio of weight to surface.

''While kites with triangular cells are strong in a transverse direction (from side to side), they are structurally weak in the longitudinal direction (fore and aft), for in this direction the kite frames are rectangular. Each side of the kite *A*, for example, requires diagonal bracing of the

* Some experiments, made by us at Blue Hill in 1896 with some of Hargrave's models of triangular-celled kite, led us to think the rectangular cell much superior in efficiency to the triangle, owing to the sheltering of the upper surface at the corners of the triangular-celled kite.

character shown at *B*, in which the framework forms the outline of a tetrahedron. In this case the aeroplanes are triangular, and the whole arrangement is strongly suggestive of a pair of bird's wings raised at an angle and connected together tip to tip by a cross bar.

"In the tetrahedral kites, shown in the plate (Figs. 4 and 5), the compound structure has, itself, in each case the form of the regular tetrahedron, and there is no reason why this principle of combination should not be applied indefinitely so as to form still greater combinations. The weight relative to the wing-surface remains the same, however large the compound kite may be. The four-celled kite (Fig. 4), for example, weighs four times as much as one cell and has four times as much wing surface.

"This, at first sight, appears to be somewhat inconsistent with certain mathematical conclusions announced by Professor Simon Newcomb in an article entitled, 'Is the Air-ship Coming?' published in *McClure's Magazine* for September, 1901—conclusions which led him to believe that 'the construction of an aerial vehicle which would carry even a single man from place to place at pleasure requires the discovery of some new metal or some new force.' The process of reasoning by which Professor Newcomb arrived at this remarkable result is undoubtedly correct. His conclusion, however, is open to question because he has drawn a general conclusion from restricted premises.

"He says: 'Let us make two flying machines exactly alike, only make one on double the scale of the other in all of its dimensions. We all know that the volume, and therefore the weight, of two similar bodies are proportional to the cubes of their dimensions. The cube of two is eight: hence the larger machine will have eight times the weight of the other. But surfaces are as the square of the dimensions. The square of two is four. The heavier machine will therefore expose only four times the wing surface to the air, and so will have a distinct disadvantage in the ratio of efficiency to weight.

"But Professor Newcomb's results are probably only true when restricted to his premises. For models *exactly alike, only differing in the scale of their dimensions*, his conclusions are undoubtedly sound; but where large kites are formed by the multiplication of smaller kites into a cellular structure the results are very different."

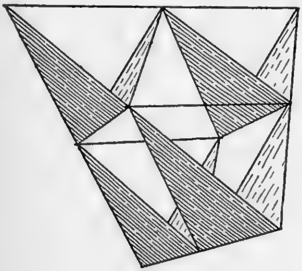

FIG. 4. Four-celled tetrahedral kite.

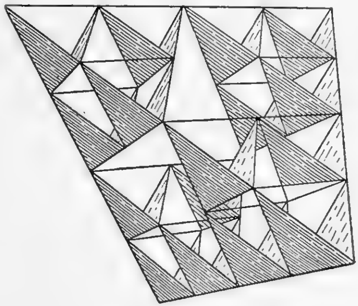

FIG. 5. Sixteen-celled tetrahedral kite.

The experiments on kites at Blue Hill have led me to the conclusion that the conditions which confront the experimenter are not so favorable as suggested by Professor Bell, nor so hard as suggested by Professor Newcomb.

I made some experiments in 1898 with a compound kite built up of a number of small rectangular kites such as are called the Blue Hill Naval Kites. In addition to the necessity of giving greater space between the cells with increasing size, I found two other difficulties: (1) When several small kites are combined into one, the pull of all the kites is concentrated on certain points which need to be strengthened by using larger sticks. This may be partly overcome by tying a string to each unit and bringing the separate strings to a single flying line at some distance from the kite. But in such a case there is a crushing strain on the central units due to the inward pressure of the outer units, so that the kite must be strengthened by trusses or larger sticks if the compound kite is to fly through the same range of wind-velocity as the unit. (2) When a compound kite strikes the ground the unit which first reaches the ground has above it the combined weight of all the other units and is instantly crushed in conditions where the unit flying alone would not have been injured in the slightest. This effect was so serious an objection that it led me to abandon the effort to build a compound kite out of units.

On the other hand, the weight of kites built on the same model does not increase so fast in practice as Professor Newcomb's law implies. The experience at Blue Hill is that if one can build a kite four feet high sufficiently strong for practical work, and it weighs one and one half ounces per square foot, then one can build a similar kite eight feet high which will weigh two ounces per square foot and be sufficiently strong for practical work. Mr. C. H. Lamson built a kite thirty feet high with two cells similar to the kites used at Blue Hill, and it weighed only about four ounces per square foot. This kite easily lifted a young man weighing about 130 pounds into the air, and, unloaded, flew beautifully in a wind of fifteen to twenty miles an hour, as witnessed by Mr. A. L. Rotch, Mr. S. P. Fergusson and myself.

The reason of this departure from Professor Newcomb's law is that only the sticks of the kites increase in size (and the necessity of this is usually partly overcome by internal bracing), while the thickness of the surfaces remains the same through wide limits.

But independent of these considerations, Professor Bell's principle of tetrahedral construction seems a promising one and further experiments are awaited with much interest, while the structure he has already developed may be found of great use by experimenters.

H. H. CLAYTON.

BLUE HILL OBSERVATORY.

SCIENTIFIC BOOKS.

The Rôle of Diffusion and Osmotic Pressure in Plants. By BURTON EDWARD LIVINGSTON, of the Department of Botany. The Decennial Publications, Second Series, Volume VIII., Chicago. The University of Chicago Press. 1902. 8vo. Pp. xiv + 150.

As stated in the preface: "The present volume will deal with the past and present of diffusion and osmotic pressure from the standpoint of plant physiology. It has a double *raison d'être.* First, it was felt that there was need of some direct and not too exhaustive account of the essential physical facts and theories of the subject. The interest of the physical chemist here has lain mainly in the light which these phenomena have been able to throw upon the ultimate nature of matter and upon electrolytic proc-

esses. It has thus been difficult for the student of physiology who is not at the same time well versed in physical chemistry to obtain the information required for the prosecution of work in this field. Secondly, it seemed desirable to bring together in a general review the literature of this subject in its biological aspects, so that the promising and unpromising points for future research might become more apparent."

Opening the book, we find that it consists of two parts; the first of forty-eight pages devoted to 'Physical Considerations.' This includes what are properly physical discussions. There is first a discussion of matter in its several states, and this is followed by a chapter on diffusion and diffusion tension.

The third chapter is devoted to 'Liquid Solutions,' the fourth to 'Ionization' and the fifth and sixth to 'Osmotic Phenomena.' In the treatment no attempt has been made to be exhaustive. Only certain aspects of the present conceptions of these matters among physicists and chemists are discussed, and their discussion is presented with the aim of clearing the way for the physiological discussions which make up the body of the book. The author especially disclaims any originality in this portion of his book, but it must be said that he has done a very great service to botanical science by making available here, for the first time, a summary treatment of these physical phenomena.

Part II. is devoted to 'Physiological Considerations,' and here in about one hundred pages the botanist will find some important discussions. The author first takes up 'Turgidity,' and follows this with a discussion of 'Absorption and Transmission of Water and Solutes,' 'The Influence of Osmotic Pressure on Organisms.' The treatment is eminently satisfactory and will prove to be very helpful to the physiological student. To show the range of the discussion in the book we may quote from the author's summary at the close of the book as follows:

As far as investigation has gone, it has been found that growth is accelerated in weak solutions and retarded in concentrated ones. The term 'growth' here includes, not only enlargement, but also the process of cell division. Also, in some cases at least, the direction of new walls is profoundly influenced by the concentration of the surrounding medium. In general, all vital processes are retarded in concentrated solutions. Reproduction, being a peculiar form of cell division, appears in some cases to be entirely dependent upon the osmotic pressure of the surrounding medium. Irritability is also greatly influenced by external pressure. Not only is this function retarded in concentrated solutions, but in some forms the direction of response to a given stimulus may be reversed by a sudden change in the osmotic surroundings. The comparative concentration of the external and internal solutions acts, in many cases, as a stimulus upon the organism, giving rise to the phenomena of osmotaxis.

All the effects of high concentration of the surrounding liquid seem to be due to extraction of water from the living cells. They may be due either to a drying-out process or to decrease in turgidity. That they are sometimes due to the former is proved by curious analogies between the various processes which extract water from the protoplasm. Whether or not this extraction of water from the protoplasm itself is the direct cause of the responses to concentrated solutions, is not yet known. The effect may be a chemical one, due to the increased concentration of the contained solutions.

This book will at once take its place as a standard work in all institutions where any attention is given to plant physiology.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

SCIENTIFIC JOURNALS AND ARTICLES.

THE AMERICAN JOURNAL OF ANATOMY, VOL. II., NUMBER 3. JULY, 1903.

A. M. MILLER: 'The Development of the Postcaval Vein in Birds,' pp. 283–299, with 10 Text-figs.

G. L. STREETER: 'Anatomy of the Floor of the Fourth Ventricle,' pp. 299–315, with 4 Plates and 2 Text-figs.

F. P. MALL: 'The Circulation through the Pulp of the Dog's Spleen,' pp. 315–333, with 1 Plate and 1 Text-fig.

F. P. MALL: 'The Transitory or Artificial Fissures of the Human Cerebrum,' pp. 333–341, with 1 Table.

A. J. CARLSON: 'Changes in the Nissl's Substance of Nerve Cells of the Retina of the Cormo-

rant, during Prolonged Normal Stimulation,' pp. 341–349, with 1 colored Plate.

R. H. Whitehead: 'A Study of the Histogenesis of the Adrenal in the Pig,' pp. 349–361, with 6 Text-figs.

E. L. Mellus: 'On a Hitherto Undescribed Nucleus Lateral to the Fasciculus Solitarius,' pp. 361–365, with 3 Text-figs.

Katherine Foot and E. C. Strobell: 'The Sperm Centrosome and Aster of *Allolobophora foetida*,' pp. 365–371, with 1 Plate.

C. F. W. McClure: 'Contribution to the Anatomy and Development of the Venous System in *Didelphys marsupialis* (L.)—Part I., Anatomy,' pp. 371–405, with 5 colored Plates and 11 Text-figs.

W. H. Lewis: 'Wandering Pigment Cells Arising from the Epithelium of the Optic Cup, with the Development of the M. Sphincter Pupillæ in the Chick,' pp. 405–417, with 15 Text-figs.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF ST. LOUIS.

The Biological Society of St. Louis was organized March 3, 1903. Dr. A. W. Greeley was elected president. The membership numbers about fifteen at present and increases at each meeting. It speaks well for the future of the society that the present membership is exceptionally homogeneous and harmonious, and that a place is rarely vacant at the meetings.

Although but four meetings have been held, and the society is yet in the formative stage, gratifying progress has been made. Current literature in botany, zoology and physiology has been reviewed. Several of the reviews have been given by members whose personal and professional relations with the authors gave to the reviews an unusual interest. Considerable original work will doubtless be presented during the next year.

At present steps are being taken looking toward closer relations with the Academy of Science of St. Louis. The meetings of the society are held on the last Tuesday evening of the year excepting in the months of June, July and August. Visiting biologists are cordially invited to attend.

W. L. Eikenberry,
Secretary.

St. Louis, Mo.

DISCUSSION AND CORRESPONDENCE.

THE ADVANTAGES OF THE GOVERNMENT CINCHONA PLANTATION IN JAMAICA AS A TROPICAL BOTANICAL STATION.

In a month's residence this spring, at Cinchona, during which time I was daily occupied in field work within a radius not greater than ten miles from the Cinchona garden, I was much impressed with the advantages of this location for a permanent tropical botanical station in America. After conversation and correspondence with botanists who have worked in this and various other tropical regions, I have become thoroughly convinced that, for such a station, no other location combines the many superior advantages of Cinchona.

A luxuriant and varied flora to meet the diverse demands of American botanists wishing to work on problems of distribution, development or physiology of tropical plants is, of course, the first requisite of a locality proposed for such a station. Associated with the extremely varied physiographic and climatic characters of the region accessible from Cinchona is a flora which makes this location preeminently advantageous for botanical work.

Cinchona is on a hill which forms a spur projecting southward from the Blue Mountain Range. Within three miles of Cinchona, in the Blue Mountains, is the well-known Morce's Gap, through which moisture-bringing clouds drift almost continuously, thus giving rise, near the Gap, to a dense and greatly varied vegetation especially rich in lichens, bryophytes and pteridophytes. In the deep valley of the Mabess River, just north of this, the vegetation is even more luxuriant than about the gap itself. Other moist gaps, many high mountain peaks and several deep river valleys directly below Cinchona Hill have a luxuriant plant covering of mesophytic type. Nearer Cinchona are the more xerophytic foothills of the Blue Mountains, and below these are the still drier plains about Kingston. These different regions, to reach the most distant of which requires not more than a two-day trip from Cinchona, afford a complete series of moisture conditions and plant

formations ranging from the broom of Cinchona Hill to the dildoes and *Melocactus* of Port Henderson. Cinchona thus possesses the chief requisite for a botanical station in the abundance and variety of its flora. There are also numerous and important accessory advantages of an even more exceptional nature.

The accessibility of Jamaica makes it a most desirable location for a botanical station. Six to ten steamers each week land passengers at Port Antonio or Kingston, and from either of these places Cinchona can be reached readily in ten or twelve hours of delightful travel by train, carriage and saddle. No other portion of tropical America has as fine a system of carriage roads in the lower country, and bridle paths in the mountain regions, as has Jamaica. To the collecting grounds about Cinchona one can walk or ride, in all directions, upon well-graded and well-drained mule paths. These paths lead to the thickets of Blue Mountain Peak, the dense forests of Mabess, the dry hills and the fertile bottoms of the Clyde, Yallahs and Hope valleys.

The stable government and efficient police system which make life and property secure are an advantage possessed by Jamaica over many tropical countries. The use of the English language throughout the island is a very evident advantage to the transient resident. As a consequence of superior political conditions, we find here government gardens, with corps of resident trained botanists familiar with the flora and very courteous in offering aid, which may prove invaluable to a worker on his introduction to the island. The government gardens are valuable adjuncts to the native flora in furnishing material of many exotics growing under practically normal conditions. In this connection it should be remembered that at Cinchona itself is an extensive garden with greenhouses containing many native and exotic temperate plants. There is also here a series of buildings which can readily be made to fill all the requirements of a tropical botanical station. Such an equipment, I believe, is not to be found in any other available location.

Health conditions at Cinchona, which is 5,000 feet above sea level, are most favorable, and the botanist is, therefore, not liable to be prevented by physical disability from taking fullest advantage of the excellent opportunities for botanical work. Malarial troubles are unknown, and the many dangers to health, so frequent in tropical regions, are here absent. Food in sufficient quantity and variety and pure drinking water from the source of the Clyde River are readily obtained. Moderate temperatures, ranging from 50° to 80°, prevail throughout the year, and the climate is stimulating to physical and mental effort.

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SHORTER ARTICLES.

THE STRATIGRAPHIC POSITION OF THE JUDITH RIVER BEDS AND THEIR CORRELATION WITH THE BELLY RIVER BEDS.*

THE readers of SCIENCE will recall that during last winter and spring a discussion was carried on in its pages concerning the age and relationships of the formations mentioned in the title of this note. This discussion, which was provoked by the publication of Osborn and Lamb's paper on the vertebrate fossils of the Belly River beds, was participated in by Messrs. Hatcher, Stanton, Osborn and Williston.

Since June 1 the undersigned have been engaged in an investigation of this subject in the field, and have reached some definite conclusions which are deemed worthy of prompt publication. Our field studies were begun on Milk River at Havre, Montana, and we examined the excellent exposures along that stream to the International Boundary, and beyond to Pendant d'Oreille Police Barracks, which is near one of Dawson's described localities, where the base of the Belly River beds is seen resting on the marine 'lower dark shales.' This is near Lake Pakowki of the maps, locally known as 'Badwater Lake.' We also examined the exposures of upper Belly River beds showing contact with the

* Published by permission of the Director, United States Geological Survey.

overlying 'Pierre shales' on Sage Creek, Canada, as described by Dawson and McConnell and continued our observations as far north as the Cypress Hills, where the top of the overlying marine Cretaceous is seen. Passing down Milk River below Havre and around the eastern end of the Bearpaw Mountains to Cow Creek and the Missouri River at Cow Island and thence up to Dog Creek, Judith, and Eagle Creek, Montana, we have studied the typical areas of the Judith River beds described by Meek and Hayden, and of the Eagle formation described by Weed.

We have become fully convinced that the Belly River beds are identical with the Judith River beds, as Dawson long ago suggested. Our conclusion is based on lithologic character, stratigraphic sequence, the vertebrate and invertebrate faunas of the beds themselves, as well as on the paleontology of the underlying and overlying beds in both Canada and Montana. We hope to present the evidence in full in a more formal paper within a few months.

Another important result of our work is the determination of the exact position which these beds occupy in the general Upper Cretaceous section of the west. For many years the Judith River beds have been generally assigned to the top of the Cretaceous and correlated with the Laramie, while the Belly River beds have been generally placed near the middle of the Upper Cretaceous, above the Benton and beneath the Pierre, though Dawson did not assert that they underlie all of the Pierre. We have found that the Judith River beds underlie about 600 feet of beds with the lithologic character and fauna of the Pierre, and that beneath them there is an equal thickness of marine beds that must also be correlated with the Pierre on account of the faunas they contain. Many of the invertebrate species from the beds underlying the Judith River have been described and figured as 'Fox Hills' species and supposed to come from beds overlying all of the Pierre.

On account of the differentiation of the beds representing the Pierre in this region into several formations, it is necessary to give new names to two of them which have not been previously recognized. For the dark clay shales with many calcareous concretions immediately overlying the Judith River beds we propose the name *Bearpaw shales*, since they are well developed around the northern, eastern and southern borders of the Bearpaw Mountains. They have the lithologic and faunal characters of the typical Pierre but represent only a fraction of that formation as generally understood.

Beneath the light-colored, mostly non-marine Judith River beds is another formation, 400 feet in thickness, which in its lower half resembles the Bearpaw shales and yields a few of the same species of fossils. Its upper 200 feet, however, contain several sandstone beds which bear a fauna that has hitherto been called 'Fox Hills.' We propose the name *Claggett formation* for these shales and sandstones underlying the Judith River beds. It is named for old Fort Claggett at the mouth of Judith River, in the neighborhood of which the formation is well developed.

Beneath the Claggett is the Eagle formation (named by Weed in the Fort Benton folio, Geologic Atlas of the U. S.) consisting of several heavy beds of coarse, light-colored sandstone, with clay shales and lignite, and having a total thickness of 250 to 350 feet. This also yields a marine fauna that has been referred to the 'Fox Hills' and is certainly more recent than any Benton or Niobrara fauna.

The Eagle formation rests on dark shales, which are known to include the Benton and probably the equivalent of the Niobrara.

The section may be summarized and compared with the sections in South Dakota, Colorado and elsewhere as follows:

		Ft.
Pierre	Bearpaw shales	600
	Judith River beds	500–600
	Claggett formation	400
	Eagle formation	250–300
Niobrara Benton	Colorado shales.	

J. B. Hatcher.
T. W. Stanton.

Judith, Montana,
July 11, 1903.

NOTES ON THE GEOLOGY OF LONG ISLAND.*

In the investigation of the underground water resources of Long Island, which has recently been undertaken by the Division of Hydrology, U. S. Geological Survey, a number of new points have been developed which are of interest at this time. Among these are:

1. Proof of the absence of a uniform 'blue clay floor.'

2. The presence of deposits of an earlier ice advance which indicate old deeply buried channels extending 225 feet below sea level.

3. The presence of erosion remnants of a topography of pre-Pleistocene origin extending undisturbed to a height of at least 360 feet above sea level.

4. The considerable number of deep flowing wells on the north shore.

The idea that there is a fairly uniform bed of blue clay of probable Chesapeake Miocene age, which dips gently southward from its outcrop on the north shore has been demonstrated incorrect by well records obtained through the work of the Commission on Additional Water Supply, and from other sources. These have also indicated that that part of the clay bed which underlies the southwestern part of the island is Pleistocene since it is underlaid by glacial beds. Several clay beds of different age have evidently been connected in the attempt to get a clay bed having a stratigraphic unity.

The examination of well samples, particularly those from the test wells of the Brooklyn Water Works, has shown in the southern part of the island, west of Valley Stream, old glacial deposits lying unconformably on an old topography, and separated from the recent glacial material by thick beds of blue clay and sands not of recognizable glacial origin. In the western part of Brooklyn these older glacial beds have been found at a depth of 225 feet *below sea level,* and are believed to throw important light on the question of early Pleistocene elevation and subsequent submergence, as well as on the position of former stream valleys.

The last ice advance found a rather irregular topography and succeeded in covering the older hills with a veneer which is for the most part quite thin. Along the backbone of the island these deposits are much thinner than has been supposed, the really prominent portions of the ridge seeming to owe their prominence more to the preglacial hills than to morainic deposits. The most marked example of this is in the West Hills, lying in the center of the island, between Farmingdale, Melville, Cold Spring Harbor and Hicksville. Here there is a marked southward tongue of hills projecting from the east and west ridge. Glacial material covers the northward slope, and reaches a height of over 400 feet; but the southern portion of the ridge has not been covered with ice and is clearly not glacial. The following section just west of Melville indicates something of its structure.

SECTION JUST WEST OF MELVILLE, NEW YORK.

Top of section about 300 feet A. T.	Feet
1. Horizontally bedded yellow sand and quartz gravel with a few very much weathered compound pebbles. Near the upper part of the section the gravel is very bright orange	38
2. Covered	3
3. Dark-colored, lavender, green and black sandy clay, weathering yellow	6
4. Horizontally bedded, finely laminated, red arkose with a few rounded quartz pebbles. Weathering product of bed below	2.5
5. Horizontally bedded, finely laminated, green, white and pink arkose	3
6. Ferruginous sandstone	0.3
7. Yellow sand with ferruginous plates	0.5
8. Irregularly bedded, gray, clayey sand blotched with red and yellow becoming more sandy above and passing into a pink or red sand with lens-shaped masses of white clay	9.5
9. Covered	0.5
10. White clayey sand with large quartz gravel	2
11. Covered	1
12. Stratified orange-colored sandy clay with ferruginous plates	1

* Published by permission of the Director of the U. S. Geological Survey.

13. Very black sand and gravel, probably stained with manganese dioxide..... 0.2
14. Coarse white sand and yellow clayey sand horizontally though rather irregularly bedded; the bedding lines being darker and rather more clayey than the rest.. 18

Mr. M. L. Fuller has found in the supposed morainic hills near Old Westbury, covered by only two feet of morainic deposits, gravel beds which are clearly of the same age as those capping the West Hills, a conclusion which is further supported by a rather complete series of samples from a well near this point obtained by Mr. Isaiah Bowman. Mr. Bowman has also found a section near the top of these hills which shows a very marked nonconformity between the thin coating of recent till and these underlying yellow- and orange-colored gravels. It is believed that the stratified gravel beds which Woodworth found capping Harbor Hill, near Roslyn (elevation 384 feet), belong to the same deposits, and that this hill is not of morainic origin.

Mr. Fuller has found a number of flat top terraces south of the moraine, which have something of the elevation of the Manhasset terraces north, suggesting their extension beneath the moraine.

At the heads of all the deep reentrant bays on the north shore there are many comparatively shallow flowing wells which seem to owe their origin to the steepness of the slope of the water table at these places, and to the difference in the resistance offered to the passage of water through the sands and through an open pipe, as well as to local clay beds. There are, however, a number of comparatively deep wells which are decidedly interesting in the face of the positive statement that a catchment area in Connecticut for wells on Long Island is impossible. Mr. Bowman has assisted in the collection of the following data regarding these wells:

Peacock Point.		
C. O. Gates	230 feet.	Elevation approximately 6 feet above high tide. Flows 30 gallons per minute.
C. O. Gates	210 "	Elevation approximately 10 feet. Flowed when first completed 40 gallons per minute. Is now being pumped.
C. O. Gates	225 "	Flows 10 gallons per minute.
W. D. Guthrie	340 "	Elevation about 10 feet. Flows 10 gallons per minute.
Mill Neck.		
Irving Cox	330 "	Elevation about 10 feet. Flows 72 gallons per minute.
Bayville.		
Dr. O. L. Jones	276 "	Flows.
Centre Island.		
A. K. Wetmore	318 "	Elevation approximately 3 feet. Flows 25 gallons per minute at high tide.
Colgate Hoyt	320 "	Elevation approximately 4 feet. Flows.
S. T. Shaw	292 "	Elevation approximately 5 feet. Flows 5 to 6 gallons at high tide. Flows slightly at low tide.
C. S. Sherman	351 "	Elevation approximately 4 feet. Flows 30 gallons at high tide, 20 at low tide.
G. M. Fletcher	370 "	Elevation approximately 10 feet. Flows 25 to 30 gallons at high tide.
G. C. MacKenzie	379 "	Elevation approximately 4 feet. Flows 75 gallons at high tide, 45 at low.
Lloyds Neck.		
Dr. O. L. Jones	248 "	Elevation approximately 5 feet. Flows 5 gallons at high tide.

Dip calculations based on data furnished by these wells give very uniform results showing a dip of about S. 23° E. sixty-five feet per mile, and as quite heavy clay beds have been found in all these wells overlying the water-bearing gravel, an insular source for this water seems almost impossible.

The investigations have hardly progressed far enough for very definite conclusions to have been reached regarding exact age and structural relations, but we hope that some of these points may be cleared up before the close of the season.

A. C. Veatch.

THE KENT COUNTY, MICH., UPLAND PLANT SOCIETIES.

It was with much interest that I read Mr. Livingston's contribution in the January, 1903, number of the *Botanical Gazette* upon the 'Distribution of the upland plant societies of Kent County, Mich.' I confess also to no little disappointment. My home is in Kent County, and several years of ecological study there have yielded me results that do not in all respects coincide with those contained in the article under review. I have not seen the author's more detailed account in the 'Report' of the Michigan Geological Survey for 1901, and perhaps some things that here seem obscure may there be made clear. In the first place Mr. Livingston's results appear to be based upon insufficient observation. The region chosen is too large, the flora too rich and complex, to allow of a thorough study in a single season. This manner of research, useful as it is in securing valuable data, is manifestly defective. Plant societies are not so simple as they appear at first sight. Subtle changes in soil, exposure and water-supply lead to corresponding changes in plant formations. A society in one region may appear distinct, while in reality it is but one phase of a larger society. Only a patient study of years of a local flora throughout all the seasons is of much worth, for only thus can a comprehensive and intelligent view of the prevalent conditions of plant life, as well as the character and actual constituents of the flora, be obtained.

Mr. Livingston has five primary plant societies: (1) The beech-maple, (2) the maple-elm-agrimony, (3) the oak-hickory, (4) the oak-hazel and (5) the oak-pine-sassafras societies. These seem hardly natural. The first two are very much nearer one another than the following three, and the third and fourth have a more intimate connection with each other than either has with the fifth.

Setting aside the strictly lowland societies, the sylvan element of the Kent County flora may well fall into four main types:

I. The elm-soft maple society of the river bottoms and other alluvial flats. *Ulmus americana. Acer dasycarpum* and *rubrum, Juglans cinerea, Platanus occidentalis, Salix nigra* and various other trees are present. Mr. Livingston has probably excluded much of this element because of its hydrophytic affinities, though his maple-elm-agrimony society corresponds to it in part. We may call this the bottoms-flora.

II. The beech-maple-basswood society of the timberlands. *Acer saccharum* and *nigrum, Fagus ferruginea, Tilia Americana, Fraxinus Americana* and *sambucifolia, Ulmus Americana* and several other trees are present. It has an herbaceous flora strictly its own. The soil is black and rich, and relatively moist. This includes Mr. Livingston's first and the greater part of his second society.

III. The oak-hickory-sassafras society of the oak-openings, having a great range of soils, being found in swamps, rich plains and valleys, as well as barren sands and clay hills. *Quercus bicolor* and *rubra* clothe the margins of swamps. *Quercus macrocarpa* and *Muhlenbergii* prefer the heavier clays, thus forming the bur-oak openings. *Quercus alba,* accompanied by the various black oaks, prefers the ordinary midland soils, though it is present throughout the entire range of the genus. *Quercus coccinea, velutina* and *imbricaria* prefer the drier soils, and with them is *rubra* (often) and *stellata* (rarely). The species of hickory show a like preference of soil. The flowering dogwood and the sassafras are also quite peculiar to the oak openings. In regions adjoining the timberlands the two floras merge somewhat into one another, though the oak flora is usually ascendant. In these forests, known as timberland openings, a rich fertile soil is present, perhaps the best of all our soils for agricultural purposes. Oaks are very rare in the true timberlands, but when present are usually of colossal size. Only *Quercus rubra* is at all frequent. Of hickories only *Carya amara* is common in the timberlands. *Juglans nigra* and *Prunus serotina* occur both in the timberlands and in the oak openings, but are now scarce except as shade trees in fields.

IV. The pine-hemlock-canoe-birch society of

the pine woods. This, as Mr. Livingston justly remarks, has disappeared in most places and has been supplanted by the flora of the lighter, drier oak openings. Only remnants of the true coniferous flora still remain, but *Epigæa repens, Gaultheria procumbens, Myrica asplenifolia* and the upland huckleberries and blueberries are still of occasional, or indeed locally of frequent, occurrence.

Of strictly mesophytic forest types we have then three, that of the beech and maple timberlands, that of the oak openings, and that of the pine woods. Of these the last is disappearing, and its remnants have, save in a few tracts of still standing pine, coalesced with the flora of the oak openings. In addition to the above, small tracts of almost pure birch are occasional, and in forests that have suffered most from fires a salicaceous type is often developed, consisting of various willows and our two aspen-poplars. Hawthorn glades, too, are of frequent occurrence, consisting mainly of species of *Cratægus, Pyrus coronaria* and various other shrubs.

Turning our attention now to details, we may well distrust the value of using common weeds, such as catnip, pokeweed, nightshade, spurges and even sand-burs as typical plants of native sylvan societies. These are plants capable of wide range of soils and conditions. They were not weeds else. Doubtless our common stick-tight (*Bidens frondosa*) is a hydrophyte, yet hardly is there any field where it is not too common. The sand-bur with us is a straggler from the sands of the Great Lakes, and is hardly indigenous except along our rivers. Now it is along all paths, roadsides and railroads. The common nightshade is a cosmopolite, and frequent everywhere.

As to the spurge, which is narrow-leaved or wide-leaved according to the society in which it grows, probably *Euphorbia corollata* is meant. I think that the width of the leaves varies with the age of the plants. In early summer, before the plant has branched, the cauline leaves are broad, but the later leaves, especially those on the branches, are much narrower. Nevertheless, the soil has also an influence on the robustness of this spurge, as it has on most species.

Dracocephalum parviflorum is given in the table as a frequent and characteristic plant of the beech-maple society. This plant I have never seen, and in the 'Flora of Michigan' published in the report of the Michigan Board of Agriculture for 1891, but three stations are given of this rare plant in the Lower Peninsula—Houghton Lake, Alcona County and Hubbardston. Perhaps it is locally abundant in portions of Kent County, and Mr. Livingston will oblige all students of the Michigan flora, if he will name exact localities.

Quercus ilicifolia similarly is given in the list as a frequent and characteristic plant of the oak-pine-sassafras society. It has not, to my knowledge, ever been reported before from any place in Michigan. According to all the manuals this oak is restricted to the Atlantic and Appalachian regions, not occurring west of portions of Ohio. It is hard to determine what oak has been confused with this strictly eastern species. The shingle oak, *Quercus imbricaria,* I have not seen north of the lower tier of counties in Michigan, though it is said to grow at Ann Arbor. The black jack, *Quercus marilandica,* is not known to occur certainly in Michigan, though it is mentioned in old lists as occurring in the extreme south. The species intended by *Quercus ilicifolia* is doubtless *Quercus coccinea,* or its variety *tinctoria,* in some of its scraggly dwarf forms.

The term *Quercus rubra coccinea* is neither exact nor scientific, as the two species are very easily separated by the mature fruit as well as by the buds. Only by those who judge the trees by the foliage at a distance are the two likely to be confused. Though they occasionally grow together, the red oak is oftener found at the margins of swamps and more rarely in the lighter soils. It, too, is occasional in the timberland forests. If the oak forest is to be divided as sharply as Mr. Livingston has divided it, the two must be separated.

The herbs given by Mr. Livingston as characteristic of the several plant societies are nearly all of the midsummer vegetation; his studies of the region quite likely took place then. Perhaps even better types could be chosen from the vernal species. Then, too,

the grasses and sedges appear not to have been studied at all, though these, next to the trees and shrubs, are the most important ecologically in most temperate regions. These omissions as well as the failure to distinguish sharply between related species—thus *Vitis cordifolia*, which is not known certainly to occur in Michigan, is confused with the very common *Vitis riparia*—and the failure also to discriminate between primary and secondary plant societies, detract seriously from the worth of Mr. Livingston's paper. The excellence of his treatment of the soils and the geological factors of the flora is thus marred somewhat by hurried and inexact observation of the flora itself. The ecologist must know his plants, or his work is worthless. He can not neglect any great group, not even the lower cryptogams, and give us a true conception of the actual plant life. He must stay with his flora till he knows it—he must see, if possible, the relation of each species with its environment, its relation too with its neighbor. If he can not cover a state or a county, let him be content with a township or a section. A broad plant survey has its uses; it has also its defects, but even so, such a survey should spring out of an intimate knowledge of local floras. A generalization not drawn from verified particulars is of no use to exact science.

FRANCIS DANIELS.

UNIVERSITY OF MISSOURI,
July 2, 1903.

DISCOVERY OF THE BREEDING AREA OF KIRTLAND'S WARBLER IN MICHIGAN.

ABOUT a month ago Mr. E. H. Frothingham, an assistant in this museum, and his friend, Mr. T. G. Gale, took an outing in Oscoda County, Michigan, and went prepared to secure specimens for the museum. On their return it was found that a male specimen of Kirtland's warbler (*Dendroica kirtlandi*) was among the bird skins which they had secured. This is one of the rarest and most interesting of North American birds, less than thirty specimens having been recorded from the United States and Canada. Mr. Frothingham has published a preliminary note of this June capture of a Kirtland warbler in the *Bulletin of the Michigan Ornithological Club*, Vol. IV. (Detroit). This is the first June record of the capture of this species. The late occurrence of this bird in northern Michigan and its relative abundance (several birds were seen and heard which were not taken) suggested that the bird was breeding in that region. In the hope of settling this point, as the breeding area of this bird was unknown, this museum sent its taxidermist, Mr. N. A. Wood, to Oscoda County to make a thorough investigation of this question and to secure specimens for the museum. Mr. Wood has just returned from this trip and has had excellent success as is shown by his having secured two nests with the young and one egg, thus establishing beyond question the breeding area of this species. A full account of the results of Messrs. Wood and Frothingham will soon be published. From an ornithological standpoint this is a very important discovery. In the *Auk* for October, 1898, Mr. F. M. Chapman writes concerning our knowledge of the North American warblers: "With the exception of several Mexican species just reaching our border, we can now write 'rare; nest and eggs unknown,' only of Kirtland's warbler." It is thus evident that this is a discovery of considerable interest.

Some unauthorized and incorrect reports have been made public, which makes it desirable to make this preliminary statement.

CHARLES C. ADAMS,
Curator.

UNIVERSITY MUSEUM,
UNIVERSITY OF MICHIGAN, ANN ARBOR.

CURRENT NOTES ON METEOROLOGY.

CLIMATE OF CAIRO.

IN 1859 the Khedive of Egypt ordered the reestablishment of the observatory which had existed at Bulaq from 1845 to 1850, but had then been closed. A site was selected and regular observations were commenced in 1868. The observatory is about three miles northeast of Cairo, on the edge of the desert, close to the military barracks of Abbassia. In 1889 Mr. J. Barois published a very

complete study of the climate of Cairo, using the observations made at the observatory for the twenty-one years, 1868–1888. Monthly bulletins were issued up to October, 1898, and in February, 1899, the observatory was transferred to the Survey Department, Public Works Ministry. In 1900 this department issued 'A Report on the Meteorological Observations made at the Abbassia Observatory, Cairo, during the years 1898 and 1899.' This report included the mean values derived from the observations of the previous thirty years, and was very fully illustrated by means of plates showing the mean daily and annual variations of the different weather elements. The work at the observatory has been carried on under the direction of Captain H. G. Lyons, R.E., Director-General of the Survey Department. Recently (1902) there has been issued a second 'Report on the Meteorological Observations made at the Abbassia Observatory, Cairo,' including the observations of the year 1900, together with the Alexandria means derived from the observations of the previous ten years. Eye readings made every three hours have been replaced by self-recording instruments. Meteorological stations have been established at Port Said, the Barrage, Assiut and Aswan. The diurnal and annual variations of the different weather elements are illustrated by means of numerous curves.

The Abbassia Observatory, and the cooperating stations, under the wise direction of Captain Lyons, are carrying on a valuable work in a country whose meteorology has always been of the greatest interest, and in which increasing numbers of Americans seek health during the winter months.

THUNDERSTORMS AND THE MOON.

In *Popular Astronomy* for June, Professor William H. Pickering summarizes some published statistics of thunderstorm occurrence in relation to the moon's phases, using data collected by Polis, van der Stok, Köppen, Hazen and others. The conclusion reached is that there really is a greater number of thunderstorms in the first half of the lunar month than in the last half, and also that the liability to storms is greatest between new moon and first quarter and least between full moon and last quarter. The difference is, however, not large enough to be of any practical importance.

RAIN AND DUST FALL IN EDINBURGH IN 1902.

In the *Quarterly Journal of the Royal Meteorological Society* (XXIX., 1903, p. 134) Dr. W. G. Black gives the results of his catch of dust and soot in the central district of Edinburgh during the year 1902. The fall of dust and soot in an open dish or gauge of 75 square inches amounted to 2 ounces, giving 3.8 ounces per square foot, or about 24 pounds for every 100 square feet.

R. DeC. Ward.

NEW YORK ZOOLOGICAL PARK.

The Zoological Society has recently received at the Zoological Park the following interesting animals, as reported by Director Hornaday: (1) A bear cub, six months old, collected at Port Muller Bay, Alaskan Peninsula, and evidently representing a species recently described as Merriam's Bear (*Ursus merriami*); this is probably the first specimen of its species to come into captivity. It is of a uniform bluish-gray color, quite different in appearance from all other bears that have thus far been received from Alaska by the Zoological Society. (2) Mr. Charles Sheldon has succeeded, after more than two years of constant effort, in securing a grizzly bear cub from Mexico. A fine young specimen, which, in spite of its black coat, is evidently a grizzly, arrived on July 15, from Mexico, as a gift from Mr. Sheldon. If this animal really is a grizzly, it represents the most southern form of that group of bears. (3) A Clouded Leopard (*Felis nebulosa*) was brought to the society by Captain Golding, from Singapore. This is a full-grown specimen, and at the proper time will be placed on exhibition in the Small Mammal House. (4) A fine half-grown specimen of the Siamang (*Hylobates syndactylus*), received from Captain Golding, is, in all probability, the first representative of its species to reach America alive. It is

a large black gibbon, with web fingers and a large air-sac, or pouch, under the throat. This specimen is in good health, and in zoological collections it even surpasses the gorilla in rarity. (5) A large and very fine specimen of the Tcheli Monkey (*Macacus tcheliensis*), of northern China, was also brought by Captain Golding. Its nearest relative is the Japanese red-faced monkey. Like the latter, it is a shaggy-haired and hardy animal. (6) A fine adult specimen of the Great White Heron (*Herodias egretta*), recently received from Miami, Florida, is probably the only captive representative of its species alive in North America. It was acquired by purchase, and reached the Park in perfect health. (7) Two specimens of the so-called 'Giant Bear' of Corea have been purchased by cable of Mr. Hagenbeck for one of the new bear dens, and will be shipped to the park very shortly.

H. F. O.

THE LISTER INSTITUTE.*

IN 1896, the centenary of Jenner's crucial experiment in proof of the efficacy of vaccination, a movement was started at St. George's Hospital to perpetuate his name by some suitable national memorial. It was decided that it should be associated with the then newly-established British Institute of Preventive Medicine, the form which it was to take being left to be determined by the Council of the Institute, according to the amount of money which might be raised. It was determined that if this amount should be so large as to place the funds of the Institute in a thoroughly satisfactory position, the name should be changed to the Jenner Institute; if the sum proved to be considerable, but less than enough for this purpose, it was to be applied to the endowment of a Jenner professorship, while if a still smaller amount were obtained it was to be devoted to founding a Jenner scholarship. The sum actually raised proved not more than adequate for the founding of a scholarship, but the Council of the Institute wishing to honor the pioneer of preventive medicine, resolved that the name of the institute should be changed. Afterwards, however, it was found that there already existed in London a commercial firm trading under the name of the Jenner Institute for calf lymph, and that it had a prior claim to the name of Jenner Institute. It was hoped, however, that as the Institute of Preventive Medicine was not preparing calf lymph, and in fact had agreed with the proprietor of the other institute not to do so while it retained a similar name, no confusion between the two would arise. This hope, however, was falsified as the two institutes were frequently supposed to be one and the same to the inconvenience of both. The mistake acquired additional probability from the fact that the local government board rented certain laboratories in the Jenner Institute of Preventive Medicine wherein the government staff prepared the lymph issued to public vaccinators. The governing body, finding the inconvenience so great, apart from the restriction mentioned above, and all efforts to meet the difficulty having failed, have determined again to change the name of the institute. The Jenner memorial committee has acquiesced with regret, and it has been agreed that its contribution shall remain invested in a Jenner memorial studentship in the institute under its new name. The governing body proposes that the institute shall in future be called the Lister Institute of Preventive Medicine. The name has, we are informed, been chosen against Lord Lister's own strong personal wish; but we believe that the profession and the public at large will agree with the governing body in thinking that no name could more appropriately be identified with the institute than that of the founder of antiseptic surgery. The proposed change has the approval of Lord Iveagh, whose munificent endowment of the institute was made just after the previous change had been effected; indeed, we are informed that it is no secret that, had it not been for that change, Lord Iveagh would then have suggested that the British Institute should be definitely associated with the name of Lister, as the similar institute in Paris is with the name of Pasteur.

* From the *British Medical Journal*.

SCIENTIFIC NOTES AND NEWS.

REAR ADMIRAL GEORGE W. MELVILLE, chief of the Bureau of Steam-engineering of the navy, retired from active service on August 8.

PROFESSOR E. C. PICKERING, of Harvard College Observatory, has been given the degree of Doctor of Science and Mathematics by the University of Heidelberg on the occasion of the celebration of the centenary of its reopening.

PROFESSOR CARL PEARSON, of University College, London, will give this year the Huxley memorial lecture, his subject being 'On the Inheritance in Man of Moral and Mental Characters and its Relation to the Inheritance of Physical Characters.'

DR. A. G. LEONARD, assistant state geologist of Iowa, has been elected state geologist of North Dakota.

DR. CHARLES B. HARE, of the University of Michigan, has been appointed government bacteriologist in the Philippines.

THE University of Edinburgh has conferred its honorary LL.D. on Professor S. S. Laurie, lately professor of education in the university, and on Sir Henry MacLaurin, chancellor of the University of Sydney, who has made various contributions to medical literature.

GENERAL A. W. GREELY, chief of the Signal Service, represented the United States at the conference on Wireless Telegraphy, which met at Berlin on August 4, on the call of the emperor of Germany.

PROFESSOR VICTOR GOLDSCHMIDT, of the University of Heidelberg, the distinguished mineralogist and crystallographer, arrived in New York on the *Kurfürst,* on August 5, and will remain in this country until November. He will visit the Pacific coast and the Yellowstone Park, and be the guest of American mineralogists at Harvard University, Yale University, Columbia University, the Kingston (Can.) and Houghton (Mich.) Mining Schools, the University of Wisconsin and the Case School of Applied Science.

DR. E. O. HOVEY sailed for Europe on the *Moltke,* on August 6. He will represent the American Museum of Natural History at the International Geological Congress at Vienna, and afterwards will spend some time in the Puy de Dôme region of southern France.

MR. HARLAN I. SMITH, assistant curator of archeology, is making investigations in the state of Washington for the American Museum of Natural History.

MR. ADOLPH HEMPEL, an American engaged in scientific work in Brazil, recently shipped to the zoological laboratory of Harvard University several living specimens of *Cavia aperea,* the wild guinea-pig of Brazil. Three of the animals have reached Cambridge in safety and will be used in experimental studies in heredity.

THE expedition of investigation sent to the Bahama Islands by the Baltimore Geographical Society returned on July 30.

THE Antarctic relief ship *Terra Nova* is expected to proceed to Hobart, Tasmania, at the end of the present month by way of the Suez canal. She will there be joined by the *Morning.*

PROFESSOR J. A. EWING, F.R.S., has been appointed a member of the Explosives Committee of the British government in the place of the late Sir W. C. Roberts Austen.

THE Royal Society has awarded its Mackinnon research studentships to Mr. F. Horton in physics and to Mr. A. L. Embleton in biology.

MR. W. E. HARTLEY, B.A., of Trinity College, has been appointed assistant observer in the Cambridge Observatory.

DR. GEORGE R. PARKIN, who recently visited the United States to make arrangements in regard to the Rhodes scholarships, is at present in South Africa on the same mission.

THE plan of changing the name of the Jenner Institute of Preventive Medicine to the Lister Institute of Medicine, referred to elsewhere in this issue of SCIENCE, has been carried into effect by a unanimous vote of the members of the institution.

THE centenary of the birth of C. C. J. Jacoby, the mathematician, occurs next year

and will be celebrated by the preparation of a memorial volume under the auspices of the third International Mathematical Congress and edited by Professor Königsberger.

Nature states that the monument which was unveiled last month at Bonn, in honor of Professor Kekulé, stands away from the city and just in front of the building of the chemical laboratories of the University of Bonn, the place in which Kekulé labored and taught for so many years and with such pronounced and conspicuous success. The statue stands on a granite pedestal, and is life-size and of bronze. On each side of the sculptured figure of Kekulé is a sphynx. The character of the man, simple and unpretentious yet convincing, is well brought out, and some of his greatest scientific achievements are clearly represented in relief on the pedestal. At the unveiling ceremony many universities and scientific bodies, foreign as well as German, were represented, and so also were numerous firms engaged in the chemical industry.

A bust of the late Sir William Henry Flower, F.R.S., director of the Natural History Department of the British Museum, the work of Mr. Brock, R.A., was formally presented to the trustees of the British Museum by the Flower Memorial Committee, of which Lord Avebury is chairman, at the Natural History Museum, South Kensington, on July 25. Speeches were made by Professor Ray Lankester, Lord Avebury, Dr. Sclater and the Archbishop of Canterbury.

We regret to record the death of Dr. W. C. Knight, professor of geology and mining engineering in the University of Wyoming, who died on July 8 from peritonitis after a brief illness.

Dr. Hamilton Lanphere Smith, professor of physics and astronomy in Hobart College, Geneva, N. Y. until 1890, died in New London on August 1, at the age of eighty-one years.

We note with regret the death of Mr. William Earl Dodge which occurred at Bar Harbor on August 9. Mr. Dodge was one of the most public spirited citizens of New York City, who gave not only of his means, but also of his time to educational and scientific institutions. He was the first vice-president of the American Museum of Natural History and of the Metropolitan Museum of Arts; one of the trustees of the Carnegie Institution and of the New York Botanical Garden, and a member of the New York Academy of Sciences and of the American Geographical Society.

M. Edmond Nocard, the well-known student of comparative pathology, died at Paris on August 2.

M. Renard, professor of mineralogy at the University of Genth, has died at the age of sixty years.

Dr. Franz Bauer, docent for geology in the Technical Institute at Munich, died on June 21 as the result of an accident while on a geological expedition.

The third International Mathematical Congress will be held at Heidelberg in August of next year. Professor A. Krazer, of Karlsruhe, is the secretary.

The second International Seismological Conference was held at Strasburg at the end of last month with representatives in attendance from about twenty countries.

There will be a civil service examination on September 2 to fill a vacancy in the position of testing engineer (male) in the Bureau of Forestry, Department of Agriculture, at $1,200 to $1,500 per annum. On September 2 and 3 there will be an examination to fill the position of miscellaneous computer at the Naval Observatory, and on September 16 for the position of nautical expert in the hydrographic office, U. S. Navy, at a salary of $1,000.

Mr. Marshall Field has written to the South Park Board of Chicago to say that he is willing to go forward with the building of the permanent Field Columbian Museum on the lake front as soon as the ground is ready for building. It is said that the cost of the building will be $6,000,000.

The daily papers report that Mr. Andrew Carnegie has given U. S. Steel Corporation

Bonds of the par value of $2,500,000 to Dunfermline, Scotland, where he was born in 1837. The income is to be used for parks, a theater, the encouragement of technical education, etc.

There was a meeting of the British Cancer Research Fund on July 30, at which the prime minister presided and made an address. It was reported to the meeting that the fund now amounts to somewhat over £50,000, and that about £1,000 had been spent during the present year, some three thousand cases of cancer having been studied.

A forest reserve of 10,000 acres in Mifflin, Juniata and Huntingdon Counties in Pennsylvania has been recently created and named the Rothrock Forest Reserve, in honor of Dr. J. T. Rothrock, the present forest commissioner.

The commission sent by the Marine Hospital Service to Vera Cruz, consisting of Dr. Herman B. Parker, of the Marine Hospital, and Drs. George E. Beyer and O. L. Pothier, of New Orleans, report three propositions as having been demonstrated beyond doubt, namely: 1. That the cause of yellow fever is an animal parasite, and not a vegetable germ or bacterium. 2. That the disease is communicated only by the bite of mosquitoes. 3. That only one genus of mosquitoes, *Stegomyia Fasciata,* is the host of the yellow fever parasite.

The opening of the Simplon Tunnel in 1905 will be celebrated by an exposition at Milan, partly of international character. Special attention will be paid to exhibits of transportation by land and water and aerial navigation.

A report has been widely circulated that a variety of basil (*ocinum viride*) possesses the property of driving away mosquitoes. Captain Larymore originally made the statement that several growing pots of this plant would keep a room free from mosquitoes, and that the leaves would stupefy them. Sir George Birdwood further reported that allied basils had long been used in India as a defense against mosquitoes and as a prophylactic in malarious districts. Experiments have now been made by Dr. W. T. Prout, principal medical officer in Sierra Leone, showing that mosquitoes flourish quite as well in the presence of basil plants as elsewhere. The efficacy of other plants reputed to drive away mosquitoes is no greater, and this should be generally known, in order that dependence may not be placed on empirical methods in place of proper means for the extermination of mosquitoes.

The Board of Aldermen of New York City have authorized an additional bond sale to the amount of $188,000 for constructing approaches to a new wing of the American Museum of Natural History, for building a foyer to take the place of the old lecture hall and for other additions and improvements about the building. Among these additions will be two assembly-rooms for the use of the New York Academy of Sciences and for other scientific meetings. Ground is being broken on Manhattan Square, west of the new lecture hall, for the construction of an addition to the museum building to contain a thoroughly modern heating, lighting and power plant. It is planned to have the apparatus for the conversion and transmission of heat, light and power open to the public, and instructively labeled and described.

The illustrated report to the U. S. Geological Survey on Precious Stones for 1902, by Mr. George F. Kunz, is now in press. The production of precious stone in this country in 1902 aggregated $318,300 in value, as compared with $289,050 in 1901, and with $333,170 in 1900. The total value of the precious stones imported into the United States during 1902 was $25,412,776, which sum was $550,209 more than that for the previous year, and twelve times the value of the importations in 1866.

The Carnegie Trust for the Universities of Scotland has made the following awards under its research scheme: Research Fellowships, Chemical, (1) Charles E. Fawcitt, B.Sc. Edinburgh and London, Ph.D. Leipzig; (2) James C. Irvine, B.Sc., D.Sc. St. Andrews, Ph.D. Leipzig; (3) William Maitland, B.Sc. Aberdeen. Biological, (4) John Cameron, M.B., Ch.B. Edinburgh. Historical, (5) Duncan Mackenzie, M.A. Edinburgh, Ph.D. Vienna.

Research Scholarships, Physical, (1) J. H. Macyagan Wedderburn, M.A. Edinburgh; (2) Henry W. Malcolm, M.A. Aberdeen; (3) James R. Milne, B.Sc. Edinburgh; (4) Thomas B. Morley, B.Sc. (Engin.) Glasgow. Chemical, (5) Joseph Knox, B.Sc. Aberdeen; (6) John Johnston, B.Sc. St. Andrews; (7) Forsyth James Wilson, B.Sc. Edinburgh. Biological, (8) Sydney F. Ashby, B.Sc. (Agric.) Edinburgh; (9) Robert Thomson Leiper, M.B., Ch.B. Glasgow; (10) Henry J. Watt, M.A. Aberdeen. Pathological, Charles Todd Andrew, B.Sc., M.B., Ch.B., Aberdeen; Alexander Matheson, M.A., B.Sc., M.B., Ch.B., Glasgow; M. Logan Taylor, M.B., Ch.B., Glasgow; S. A. K. Wilson, M.A., M.B., Ch.B., B.Sc., Edinburgh. Historical, Alan O. Anderson, M.A., Edinburgh. Economical, John Young, M.A., St. Andrews. Linguistic, John Purves, M.A., Edinburgh. Research grants were also awarded to fifty applicants.

According to the report to the United States Geological Survey for 1902 by Dr. Joseph Hyde Pratt, the production of crude tungsten ores during 1902 amounted to 183.5 tons, of which not more than a few tons were sold. The production of 1901 was 179 tons of concentrated ore, valued at $27,720. The larger part of the production of 1902 was from Colorado, with a smaller amount from Connecticut. No new localities were developed during 1902. Almost the entire production of commercial molybdenite was by the Crown Point Mining Company, of Seattle, Washington, from their property in the western part of Chelan County. The production amounted to about twelve tons. The value of the ores is very erratic, the prices quoted varying from $1,500 to $100 per ton. There was a marked increase in the production of uranium and vanadium minerals in 1902, which, as reported to the Survey, amounted to 3,810 tons, valued at $48,125, or $12.63 per ton. This, of course, represented the crude ore. In 1901 the production was 375 tons of crude ore. A portion of the uranium ore was treated, giving a concentrated product of 25 tons, which was valued at $8,000, or $320 per ton. Although it has been determined that these metals have beneficial effects when used in the manufacture of steel, considerable study of them is necessary before their commercial positions with respect to one another or to nickel and chromium can be definitely determined. Questions came up as to which of the various irons hardened by them are best adapted for steel drills, for dies and shoes in stamp mills, for car axles, carpenters' tools, etc., as to which will retain the best cutting edge, which will heat the least when in use and which will make the toughest iron. Mr. A. B. Frenzel, of Denver, Colorado, has offered prizes at a number of the schools of mines in the United States for investigations of these ferro-alloys in relation to the matters mentioned above.

A new division has been established in the Geological Survey, entitled the 'Division of Alaskan Mineral Resources,' which will embrace all of the investigations and surveys being carried on in Alaska. This division is coordinate with the others of the geologic branch of the survey and its chief will report to the director. For some years past extensive surveys and investigations have been systematically carried on in Alaska, the results of which have appeared in more than twenty publications of the Geological Survey, accompanied by extensive maps. These reports have been for the most part devoted to the discussion of the mineral resources of Alaska, and have proved of great practical benefit to prospectors and miners. This work is being pushed as rapidly as the appropriation will allow. The Alaskan division has now seven parties in the field, of which two are mapping and investigating the placers of the Nome region, two the gold deposits of the Yukon, another the coal-bearing rocks of the Yukon, the sixth is making a reconnaissance of the petroleum fields of Controller Bay and Cook Inlet, and the seventh is making a reconnaissance of the vein deposits of the Juneau and adjacent districts. Mr. Alfred H. Brooks has been made chief of the new division, with the official designation of geologist-in-charge, Division of Alaskan Mineral Resources. Mr. Brooks has been en-

gaged in Alaskan investigations for the last six years, during which time he has made many extensive journeys in the territory. He has had administrative control of the geologic work in Alaska for the last two years, and will now combine with this the charge of the topographic work. He leaves Washington about July 20, for an extended tour in Alaska, and will visit a number of the important mining districts in which investigations are being carried on.

The *Deutsche Industrie Zeitung,* as abstracted in the Consular Reports, says that of all the countries producing steel in 1902 the United States led, with an output of 15,000,000 tons. These figures grow in importance when it is remembered that the world's production in 1894 was only 12,851,000 tons. Germany's production in 1902 was 7,780,000 tons, one-half that of the United States; while England's was only 5,000,000 tons, or one-third the production of the United States. The world's total steel output for 1902 was estimated at 35,000,000 tons. This would indicate a growth of 700 per cent. in twenty-two years, or an increase from a little more than 4,000,000 tons in 1880 to 35,000,000 tons in 1902. The great increase is due to the introduction and improvement of the processes, notably the flame furnace. Pennsylvania leads all parts of the world in the use of this furnace, followed by Illinois, New England, Ohio, etc. The steel produced by the Bessemer process during the last fifteen years was used mostly for rails. In England more than half of the steel produced by the Bessemer process went into rails. In Germany and the United States the proportion is not so large. While the United States produced 9,306,471 tons of steel ingots in 1902, it turned out only 2,876,293 tons of steel rails, or about 30 per cent. of the steel-ingot production. In Germany the amount of Bessemer steel put into rails is proportionately smaller. Because of the resisting power of the steel, the wear and tear on the rails is far less; but the manifold uses to which the steel can be put has taken away somewhat from the importance of steel-rail manufacture. The last twenty years has resulted in an age of steel. Three times as much steel is now produced as in 1894. The universal opinion seems to be that the production of steel is to go on increasing. If, during the next twenty years, the same rate of increase is maintained as marked the past, 1923 will see an advance of from 20,000,000 to 25,000,000 tons in the world's total production. In this enormous increase the United States, according to experts, is to play the important part. At the very least, this opinion seems reasonable. The United States now uses in a year 30,000,000 tons of the very best iron ore. In twenty years this would mean a total of 600,000,000 tons—possibly the exhaustion of the sources of supply.

UNIVERSITY AND EDUCATIONAL NEWS.

The grounds of Clark University, Worcester, are to be surrounded by an ornamental wrought iron fence, estimated to cost at least $30,000, to be given by Mrs. Susan W. Clark, widow of the founder of the university.

The London County Council has resolved, subject to certain conditions, to contribute £20,000 a year for the maintenance of the new Institute of Technology which it is proposed to establish in connection with the University of London.

The University of St. Andrews has established a lectureship in geology with a salary of £300, the appointment to which will be made in September.

Dr. Charles S. Howe, professor of mathematics and astronomy in Case School of Applied Science, has been elected president.

Professor Kendrick C. Babcock, assistant professor of history at the University of California, has been offered the presidency of the University of Arizona.

Professor J. A. Ewing has resigned his chair of applied mechanics at Cambridge University which he has held since 1890.

Dr. Sievers has been promoted to a newly-established chair of geography at the University of Giessen.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 21, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE NEW OPPORTUNITY FOR SECONDARY SCHOOLS.

PROFESSOR G. G. RAMSEY, of the University of Glasgow, said last November in an address on 'Efficiency in Education,' while speaking of the need of new definitions and new standards in education:

"It is not merely that new subjects have been introduced for which a place must be found; but also that the demand for higher education of some sort, and of the best sort available, is being made on behalf of a much wider and larger class than formerly. It is no longer a select class, consisting of those destined for professions and the higher walks of life, whose needs demand attention; the nation has at last been roused to the necessity, which many of us have been preaching all our lives as a matter of national concern, of training to the utmost the brain power of the community, and of bringing within the reach of every capable mind, in every class, the benefits of a liberal education. There is," he adds, "at this moment a boom on amongst us in this matter of higher education; and it is of the greatest consequence to the country that this boom should expend its force in the most promising directions."

In the course of his address, this eminent 'professor of humanity' frankly admits that, 'the highest literary and classical edu-

cation appeals to only one side of human culture.'

There is nothing very new in this last remark, for we have all said the same thing in some form, but it is new to have such a man say it so plainly. It reminds one of an earlier plea for a broader system of training by Dean Farrar, in which he said, after thirteen years' experience as Master of Harrow: "I must avow my distinct conviction that our present system of exclusively classical education, as a whole, and carried on as we do carry it on, is a deplorable failure. I say it knowing the words are strong words, but not without having considered them well. It is no epigram, but a simple fact, to say that classical education neglects all the powers of some minds, and some of the powers of all minds."

But it is not my purpose to attack nor my wish to undervalue classical culture. There is not a single well-arranged course of literary study which I wish to overthrow. What I ask is the establishment of additional courses, which are as truly liberal and, for the great majority of youth, much more efficient and timely. I have quoted two eminent, open-minded authorities to the end that all of us may be open-minded in the consideration of the great educational problems of to-day.

The opportunity and duty for secondary schools rest upon two conditions which must be briefly stated: First, secondary education is becoming more general; in the next place, the demand is imperative that the curriculum of the secondary school become* broader. Let us examine these conditions.

1. There is an increasing tendency to require school attendance up to a certain age or to the completion of a certain standard of scholarship. Recent legislation is in the direction of more schooling and higher education, and even where legislation is wanting, public opinion is strongly in that direction; this is conspicuous where manual training has been incorporated into the secondary program.

In England and Germany elementary education is compulsory and, therefore, universal up to what we call the high school. The same is true in many states in this country. A few years ago there was serious opposition to high schools supported by taxation, and the great mass of children had no expectation of entering a secondary school. At the present time that opposition has vanished, and in many communities it is the rule and not the exception for a graduate of the highest grammar grade to enter the high school.

The rapid growth of the secondary school can not escape observation. The increased range and efficiency of the grammar schools is partly the cause and partly the consequence of increased privileges in the way of high schools. This is strikingly shown in many cities, notably in the two chief cities of Missouri, St. Louis and Kansas City. In St. Louis the board of education is building two fine manual training high schools, which will be opened for students next year. These schools have long been necessary, but an unfortunate provision in the state constitution kept the school tax at so low a rate that the secondary features were greatly neglected. Nearly a year ago the constitution was amended, raising the limit of taxation for schools from four mills to six mills per dollar of assessed value, or a dollar and a half of actual value. To a surprising degree the prospect of new schools has strengthened the higher grammar grades. The feeling that the high schools belong to all children is taking deep

* I do not accept the fanciful distinction President Hadley makes between secondary education and the curriculum of the secondary school. To me they mean the same.

root, and I predict that the high school attendance in St. Louis will double within two years.

This result has actually been achieved in Kansas City. Its high school attendance has in seven years increased *one hundred* per cent., while its population has increased *fifty* per cent. This is largely explained by the organization and equipment of what appears to me to be the largest and most successful manual training high school in the world. The enrollment at the manual high school has been as follows from the start, beginning with 1897: 843, 1,114, 1,244, 1,492, 1,677, 1,706 in 1903.

But not the west alone. The high school attendance has increased 48 per cent. in Springfield, Mass., while the population has increased 19 per cent. In Worcester, Mass., the high school attendance increased 124 per cent., while the population increased 36 per cent. Boston and Philadelphia show similar gains; in short, there is hardly a prosperous community where a similar growth is not observed.

It would be unreasonable to attribute this growth to any one thing, as for instance the introduction of manual training. Beyond question that has had much to do with it, but increased wealth, improved social conditions and a growing conviction that education is a good business investment, have had much to do with bringing about this gratifying result. Twenty years hence secondary school diplomas will be relatively as numerous as elementary school diplomas were twenty years ago.

2. We must be getting our houses in order to receive, educate and train the coming army of boys and girls. They will want the best, and their wishes will be law. The demand for broader curriculum for the secondary school is imperative. The classical academy and the classical high school will continue to exist and do valuable work. No one who knows the value of high grade classical training wishes to do away with such schools or to lower their moral and intellectual tone, but we must not shut our eyes to the fact that they do not cover the whole field of secondary education, nor do they meet the wishes and needs of the great majority of fourteen to fifteen and sixteen-year-old boys and girls. It is not a question of brains, nor of morals, nor of health; it is a question of environment, of taste, of ambition, of outlook. The men and women who are to do the world's work need and wish to be trained to do it well. They must not only be strong, but they must be versatile, skillful and wise. Solomon prayed for a 'wise and understanding heart.' In a measure that is what every healthy boy and girl prays for. I would put emphasis on the word 'understanding.' Everything in education should conduce to understanding, just as everything which conduces to understanding is education. I have no use for studies which yield culture without understanding—in fact I deny that there is valuable culture without understanding. I have no patience with people who know that a study is useful only in proportion as it is understood, and yet claim that its culture value is inversely as its utility in practical life. Whether we teach Latin, geometry, physics, the theory of a tool or a process of construction, let us give our pupils understanding. The pupil who has formed the habit of understanding what he sees or reads or handles will carry into the world the habit of studying life's problems with eyes, hands and brain, till he understands them.

There is really no necessity for a plea for new courses of study in the secondary school. We are substantially agreed on that point. Not one half of the boys and girls of Boston ever get inside of a high school. Why is it? The high schools are

supported by taxation and they are as free as the grammar school to all. It is not because the people are poor—that excuse would cover but a small per cent. of the absentees. It is not because they have not ample brains and average common sense. A small percentage are undoubtedly stupid, but some of the stupid, as we all know, find their way into the high schools and colleges. These two reasons, poverty and stupidity, are the reasons generally given, but the great bulk of the absence from secondary schools has still to be explained.

In my judgment the best word to explain the non-appearance of over fifty per cent. of boys and girls in our secondary schools is 'incompatibility.' There is a lack of harmony. The school does not give what the pupils want.

Now do not jump to the conclusion that because the boy does not want what the school has to give he is altogether unreasonable and low-minded. He wants, as Emerson says, 'an education to things.' He sees the world at work around him and he knows that he must work, and he wants an education that will enable him to work intelligently, efficiently and to his advantage. If he is conscious of capacity, the school must convert it into faculty. The school must help and not hinder him. He cares not for authority, has no respect for traditions, and ancient history does not interest him. He wants the latest news; he respects what is in force to-day; he must see with his own eyes; he himself must unlock the doors, and with his own hands unbar the gates of the future. He believes that Robert Ingersoll told the truth when he said that, "Much that is called education simply unfits men successfully to fight the battle of life. Thousands are to-day studying things that will be of exceeding little importance to them or others. Much valuable time is wasted in studying languages that long ago were dead, and histories in which there is no truth."

And when those boys who *must* make their own living and build their own homes, and those who *wish* to make their own way in the affairs of the world, turn away from continuous literary studies, even the literary world approves their choice. It would be the height of folly to go into the streets, the shops, the factories, the stores, the offices, the fields, the gardens, the stables and the general loafing places—to go into all the places where fifty or sixty per cent. of the boys from fourteen to seventeen years are found, and, if we could, bring them all into school and teach them Latin, Greek and mathematics, as I was taught till I was eighteen years old, as though we expected them all to go on to college, and become literary or professional men.

Said President Wilson, of Princeton, in his inaugural address: "The college is not for the majority who carry forward the common labor of the world, nor even for those who work at the skilled handicrafts which multiply the conveniences and the luxuries of the complex modern life. The college is for the minority."

The average secondary school, if it prepares pupils for anything, prepares them for college; and since the college is not for the majority, the secondary school is not for the majority. What then is there for the majority? If they are to have secondary education at all it must be something different.

The curriculum must be broadened. It must touch modern life, modern conditions, modern forces, modern responsibilities. As Huxley expressed it: 'It is folly to continue, in this age full of modern artillery, to train our boys to do battle in it equipped only with the sword and shield of the ancient gladiator.' Sir Lyon Playfair changed the figure in protesting against

the English system of secondary education, as follows: "In a scientific age and in an industrial section, an exclusive education in the dead languages is a curious anomaly. The flowers of literature should indeed be cultivated, but it is not wise to send men into our fields of industry to reap the harvest, when they have been taught to pick the poppies and push aside the wheat."

When the wide-awake, inquisitive boy knows that electricity, and steam and heat, and the art of designing and constructing automatic machines can be studied and understood with no more effort and in less time than it takes to commit to memory a Latin grammar, or to read Demosthenes without a dictionary, and that those former things are ten times as interesting as the latter, and a hundred times as likely to be of service to him in the struggle for life and the battle for success, he will choose them if he has a chance. And it is our business to give him a chance. To quote Emerson again: 'We must take the step from knowing to doing.' I read the other day that in Indianapolis, Ind., where they have two fine high schools, one of the older and one of the newer type, 580 pupils from the grammar grades applied for admission to the high schools. Four hundred of them, or 69 per cent., applied for the manual training high school. This indicates not so much a change of sentiment in regard to the values of the classical school as the creation of a new high school constituency.

We want living languages and living issues. We must teach the duties of an American citizen rather than the manner of life of a slave-owner in Athens or Babylon. We must teach the mechanics, hydraulics, electricity and chemistry of today rather than the physical theories of Aristotle and the alchemists. We must illustrate and explain the battle of Santiago rather than the battle of Salamis. It is a thousand times more interesting and more useful to the average boy to know how modern engineers tunneled under the Alps than to read the fabulous stories of how Hannibal made a road over them; to know how Eads built a railway bridge across the Mississippi, than to decipher Cæsar's footbridge over the Rhine; to analyze and comprehend the water-works of Boston or London, than the hydraulic system of ancient Rome, marvelous as it was; to master the universal language of drawing, than to get a smattering of a language which no one speaks and no one writes; to become familiar with modern methods of construction and the skillful use of tools and machinery, than to speculate over the Tower of Babel or the Pyramids of Egypt.

Here is the magnificent opportunity for the secondary school; to use a military phrase, let it change front and face the world of to-day. Let it open all its doors and windows to the humanities of to-day. Look around you and look forward, not always backward. Weep not, as Ruskin did for departed days, for the lumbering stage-coach, the storm-driven wooden ships, the hand loom, the log hut, and the good old days of blissful feudalism. I am amazed when I think how much we are spellbound by tradition. Perhaps I have been as footloose as any of you, yet I find myself continually approving of educational features for no good reason except that they are fashionable. We somehow seem to think it means far more and is in far better form to know that the nymphs gave Perseus a helmet which Vulcan made for Pluto, and which rendered him invisible, than to know that Thomas A. Edison invented the incandescent lamp and made it possible for Niagara Falls to light a hundred thousand of them, twenty-five miles away; and yet we don't believe one word of the former

story, while we accept every word of the latter.

It is of course a matter of association. Sir Leicester Deadlock, in Bleak House, could not endure a man who experimented with a steam engine and who seemed quite at home with a coal-burning furnace. He drew inferences as you and I do. Sir Leicester inferred that the man who understood engines and power houses must be ignorant of polite learning and unfamiliar with the ways of good society. So you jump to the conclusion that the man who knows all about Edison and the generation of electricity is probably ignorant of Greek mythology and not proficient in spelling.

Well perhaps you are right and perhaps you are wrong. But this is certain: It is no longer safe to assume that your engineer or your electrician is an uneducated man, or that he lacks culture. There is more than one kind of culture. Emerson speaks of 'having a mechanical craft for culture.' By culture I mean a knowledge of some of the best things that have been done and said in the world; a certain refined and gracious spirit; a soul of honor; a depth of human sympathy; a wise and understanding heart; an all-pervading love for what is useful and true, and therefore good and beautiful. That kind of culture can be gained with or without much ancient literature; with or without much mathematics; with or without the physical, biological or dynamic laboratory; with or without the art room or the drafting room; with or without the theory of typical tools and correct methods of construction. There is no necessary divorce between the skilled hand and the cultured mind; both are needed for the highest culture.

I am not pleading to-day for the minority who are already in our secondary and higher schools. I am not asking that you deny the 'classics' to those who ask for them. Get the classic arts and the mechanics too if possible; but I am pleading for that vast majority who are not in secondary schools but who are coming, many of whom will inevitably go on to our colleges and technical schools. I beseech you, set up no narrow aims, no insufficient motives in managing these schools. Then let us broaden the spirit and scope of the colleges and universities. Nine out of ten of them assume that the college curriculum is for students aiming at five professions or occupations, including teachers and 'people of leisure.' The last are those who inherit wealth, and are, therefore, not under the necessity of earning their own living. When Hawthorne got through college he carefully scrutinized the occupations which seemed to be open to him. He reported his conclusions as follows in a letter to his mother: 'I can not become a physician and live by men's diseases; I can not be a lawyer and live by their quarrels; I can not be a clergyman and live by their sins. I suppose there is nothing for me to do but write books.'

Now the majority who are coming will inherit no wealth; they expect and desire to earn their own living. We do not need them as lawyers, or ministers, or doctors; we hope they won't all write books; we do need them as teachers, as engineers, as accomplished workmen in our industries and in our unhistorical methods of trade and commerce. Let us persuade them that education and skill dignify and adorn every occupation, every calling; that the legitimate fruit of a combination of literary and scientific culture and technical skill in dealing with materials and forces will be a generation of stronger, abler and more successful men in industrial, commercial and political life.

Let us begin, if you please, by training

a part of this majority to become superior craftsmen, rather than to feel that they are superior to all crafts, and to be unwilling to be put to any.

Let us avoid the serious mistake of educating the majority as though they were a privileged minority. Let us accept once and for all the doctrine that any occupation may be ennobled, enriched and dignified by education, training, and skill; that there are a score of new professions requiring a high order of intellect, and the close and continued study of subjects as difficult and as profound as are the branches which lead up to the so-called learned professions.

The educated and highly accomplished architect or engineer is a learned man, and he stands second to none in the forum and in the arena of activity to-day. There is a great and an increasing demand for such men in every city in the land. I have been training engineers for nearly half a century, and I know how inadequate the supply is. In St. Louis we are quite unable to furnish graduates of our manual training school as fast as they are wanted in all kinds of industrial work. The other day I was told that there were twelve hundred educated engineers in Pittsburg, and the demand was continually for more. The number of students in the technical schools—that is, the schools for applied science in the various branches of engineering and architecture—ought to be as numerous as in colleges for letters and pure science, and they will be as numerous when the secondary schools recognize the majority as they now do the minority. The number of students in colleges and higher technical schools is increasing in this country at the rate of five per cent. every year.

What has been done in Philadelphia, Kansas City and in some other cities, and what is now doing in St. Louis, ought to be done in every city that can maintain a high school, viz., offer facilities for a secondary education looking towards industrial occupations and technical professions equal, at least, to those offered for students looking forward to clerical or mercantile occupations and the traditional professions.

Are you doubtful about the intellectual, moral and social standing of the graduates of schools which incorporate a thorough course of manual training, including practical drafting with a modest academic course? If so, it will be of value if I give you the record of the graduates of a high grade manual training school which has been in existence twenty-three years and has graduated twenty classes. I refer to the school connected with Washington University in St. Louis.

Before I read the list please bear in mind that the school does not aim to produce mechanics. Not every boy is fit to be, or has the ability to be, a good mechanic. When the whole boy has been put to school three or four years he finds out what his strong points are, if he has any, and he works into the occupation where he is most likely to achieve success. In point of fact the round plug gets into the round hole, and the square plug gets into the square hole, with an infinite sense of compatibility pervading both plugs and holes. Many graduates who started life as mechanics have pushed along, and have been called up higher, to greater responsibilities and to larger rewards. We do not pretend to know what a boy is by nature best fitted for, nor what opportunities his environment will offer. We attach no value to the whims and fancies of a thirteen-year-old boy, and very little to the ambitious hopes of parents. When a boy stands four-square on a broad foundation he is pretty sure to build aright.

OCCUPATIONS OF THE GRADUATES OF THE MANUAL TRAINING SCHOOL OF WASHINGTON UNIVERSITY, ST. LOUIS.

Agriculture and stock raising	14
Architects	24
Artists	4
Banking	7
Bookkeepers, general assistants and clerks	153
Cashiers	5
Chemists	9
Contractors	2
Dentists	4
Draftsmen	100
Electricians	19
Fieldmen	4
Foremen	3
General managers	32
Insurance	9
Lawyers	30
Library	1
Mechanics	12
Merchants and manufacturers	90
Ministers	1
Physicians	22
Real estate	18
Reporters	2
Salesmen and agents	41
Students	59
Superintendents of manufactories	44
Teachers	39
Technical engineers	63
U. S. Navy engineers	4
Miscellaneous	12
Unknown	56
Number who have taken degrees elsewhere after leaving the Manual Training School	159

This outcome suggests an important function of a secondary school which I have not seen clearly stated. The secondary school should enable a boy to discover the world and to find himself.* I use the word 'discover' in the sense of *uncover,* that is, *lay bare* the problems, the demands, the openings, the possibilities of the external world. A boy finds himself when his internal world is laid bare to a conscious examination and inventory.

* "The successful school must achieve two positive results: on the one hand it must reveal the world to the pupil; on the other it must reveal the pupil to himself."—Walter J. Kenyon, in the *School Journal,* March, 1893.

If the secondary school shall do those two things well it will do what generally has never been done at all. This can not be done with a single curriculum, along any line. All your windows and doors must be open.

While I plead for the neglected majority and point out the glorious opportunity of the secondary school I must speak a word for the benefit of the minority to whom of course all of us belong.

The great mass of American teachers has as yet no adequate conception of the fine invigorating effect of a correct system of manual training upon the mind and character of a healthy, normal boy. I do not refer to manual training falsely so called; to the wishy-washy tinkering with tools and materials where the child is the victim of his own whims, and of his teacher's ignorance; where under the pretense of developing originality, altruism or concrete expression, the child is prematurely misled, misdirected and mistreated, until the possibility of well-timed and well-regulated manual training is utterly lost. I regret that I must speak so strongly of a tendency utterly to emasculate manual training by a method of treatment which would be instantly condemned if applied to any other branch of study. We must, I suppose, excuse a great deal of sentimentalism and extravagance on the ground that the most recent converts are apt to be unbalanced by excess of zeal.

Manual training furnishes many of the elements of culture and discipline which are lacking in the ordinary secondary course of study. Contact with the concrete; clear concepts of materials, forces and instrumentalities; exact knowledge of mechanical processes; analyses of complex operations; the idea of precision; habits of system, of foresight and of intellectual honesty. These mental, moral and phys-

ical elements are invaluable. It is not strange that President Eliot said: "Manual training not only trains the eye and hand, but develops the habit of accuracy and thoroughness in any kind of work. It develops the mental faculties of some boys better than books do." Professor James, of Harvard, says that "The most colossal improvement which recent years have seen in secondary education lies in the introduction of manual training." And Dr. Stanley Hall says: "No kind of education so demonstrably develops brain as hand training."

The minority should have the benefit of this improvement and of those benefits most assuredly. So here is another splendid opportunity for the secondary school.

To a graduate of Harvard who has for years labored assiduously in secondary and higher technical education to establish a system of instruction which looks squarely towards modern developments in science and the industrial arts, it is extremely gratifying to find his *alma mater,* under the leadership and inspiration of its distinguished president, taking high ground both in the organization of technical branches of instruction and in the vindication of their dignity and worth. One is led to apply to Harvard the language the London *Times* used in speaking of the establishment of engineering courses in the University of Cambridge, England: "It is pleasant to see our oldest university, while remaining faithful to all the traditions of its venerable past, at the same time displaying an intelligent appreciation of the wants of the future, and affording to the most modern forms of learning the nurture and support which, for many centuries, it has afforded to those forms with which alone our forefathers were familiar."

C. M. Woodward.

June 4, 1903.

TEN YEARS OF AMERICAN PSYCHOLOGY: 1892–1902.

II.

THE RELATION OF THE ASSOCIATION TO OTHER SCIENTIFIC ORGANIZATIONS.

Our association began its career as an academic affair. Fourteen universities and one lunatic asylum were represented among the original twenty-six members. Just one third of the institutions were in New England and shared just fifty per cent. of the membership. Since then every meeting has been held under the wings of a university. Until the fourth annual meeting, the psychologists were content to stand on their own feet scientifically, and not to yield to the social attractions afforded by joining the numerous groups of scientists which were meeting here and there over the country. In 1895 the psychologists met for the first time with the American Society of Naturalists and Affiliated Societies. The philosophical pressure upon our organization came to something of a focus at this time, and was yielded to a year later, which was marked by a sudden influx of metaphysical papers and the formation of a section for the presentation of them. Seven meetings have been held with the naturalists, with whom a joint discussion has been held four times on various themes, in which a psychologist has participated as our representative. Our association has been invited four times to turn aside from its individual or annual way, and unite its associated interests with other scientific organizations, such as the American Association for the Advancement of Science and the British Association for the Advancement of Science. Joint sessions have also been held with the American Physiological Association, the Western Philosophical Association, and two summer meetings in connection with Section H,

Anthropology, of the American Association for the Advancement of Science have been authorized. We are now in active research cooperation, through representatives on joint committees, with the American Association for the Advancement of Physical Education, for gathering statistics and measurements, and certain other societies for preserving speech records. We have our three committees on physical and mental tests, vocabulary and bibliography. Once the pride of the association has been quickened into solicitude for the type of representatives of American psychology given standing in the international congresses of psychology. And here we are, one with numerous societies, bulked together in Convocation Week.

In accepting the overtures of scientific sociability our association has doubtless aided greatly in bringing about a change in that state of the public mind which once regarded the psychologists as something *sui generis*, who could not mingle in the truly social precincts of science. During the decennium there has appeared a decided recognition of the psychologists, at least, accredited through the affable hand and voice of other departments of science. Whether this scientific friendship extends so far as to include the very genius of what our science has to teach respecting both nature and mind is a phase of our growth which may well be reserved for more mature consideration. One might well say that all other sciences should affiliate with psychology, the true mother of science, inasmuch as she alone probes the sensory foundations of all our knowledge of nature and her processes. The present needs of our science make necessary a great deal of missionary work to be done on our part, and in affiliating our corporate interests, let us become fully aware of the doubling of the responsibility to our association and its fundamental issues.

TEN YEARS OUTSIDE THE ASSOCIATION.

It would be presuming too much in the face of the most general and well-known facts to imply that the chief features of the last ten years of American psychology are to be found within the history of our association. Having reviewed this in detail, we must now turn to that larger area of activity which lies without the organization, where we may, possibly, get a truer perspective of what the years have brought forth among us.

The laboratory represents, beyond all question, the most interesting feature in the recent development, and the largest promise for the future of psychology. Herein both the method of research and the pedagogy of the subject find their true abode. At the time of the first annual meeting of the American Association there existed some fifteen laboratories in America, fully equipped for research or in possession of special facilities for demonstration. They possessed an equipment which has been valued at about thirty thousand dollars. The institutions maintaining these laboratories were the universities of Pennsylvania, Wisconsin, Indiana, Clark, Nebraska, Harvard, Columbia, Iowa, Cornell, Wellesley (college), Yale, Brown, Michigan, Catholic University of America and the McLean Asylum, which began laboratory measurements in 1889. In the next two years ten additional laboratories were opened when the aggregate valuation of the equipment approximated sixty thousand dollars, and the annual appropriations for maintenance amounted to ten per cent. of the cost of equipment.*

* According to Delabarre, 'Les laboratoires de psychologie en Amerique,' *L'Année psychologique*, 1894, pp. 209–255.

At the present time, according to a recent inquiry,* this varied experimental equipment is found in forty colleges and universities in the United States, besides a few private laboratories and those connected with a few pathological institutions. The list includes twenty-six educational institutions additional to those named above. Arranged in alphabetical order these are Amherst, Bryn Mawr, California, Chicago, Cincinnati, Colorado, Dennison, Illinois, Leland Stanford Jr., Minnesota, Missouri, Mt. Holyoke, New York, Northwestern, Oregon, Princeton, Randolph-Macon Woman's College, Smith, State College, Teachers College, Tufts Medical School, Ursinus, Vassar, Washington, Wells, Wesleyan (Conn.). Twenty-six of these institutions are private, and fourteen are public (state). This distribution is strongly suggestive of the query, whether scientific psychology is purely academic, or whether it is lacking in that practical aspect and value sufficient to secure legislative appropriation of public moneys for its equipment and maintenance. Here, at least, is a practical problem of policy for our association to consider. It is known that a number of educational departments in some colleges and some normal schools have facilities for teaching psychology, but the exact data are not available. According to my present information, twenty-five per cent. of the men who are operating these laboratories and giving instruction in psychology as experimental have been trained in the Leipzig Institute. Scarcely any three of our American institutions can equal this representation and influence in this particular direction. We should not fail properly to interpret this interesting item of training in our American psychology.

* Made by Dr. E. B. Huey, who has kindly supplied me with the following data.

This is not the time, nor is there space, to go into the minuter details of the work that has been done in these institutions during the ten years. That there have been persistent efforts made in these workshops of inquiry is well attested by the growing list of experimental studies appearing in the two American periodicals and the number of rather private publications. During the decennium *The American Journal of Psychology* and *The Psychological Review* (founded in 1894) have published over eleven thousand pages of research, critical and review literature, almost equally divided between them. The latter has issued seventeen monographic studies in psychology in its special series of Monograph Supplements, begun in 1895. Lesser foundations for psychological publications are the *Studies from the Yale Psychological Laboratory*, begun in 1893, the *University of Iowa Studies in Psychology*, begun in 1897. Numerous articles on psychology have appeared in *The Monist* (founded 1890), the *Open Court* (founded 1887), and the *Philosophical Review* (established in 1892) has devoted a large portion of its pages to specific discussions in our science. Several universities, such as Chicago, Columbia and Cornell, have university serial publications, generally entitled contributions to philosophy, psychology and education, in which psychological studies frequently find place. While other institutions have bulletins, such as Missouri and Wisconsin, in which more rarely appear investigations of psychological topics, *The University of Toronto Studies* has a Psychological Series of four issues. Very recently there have appeared additions to these more special modes of publication, such as Witmer's *Experimental Studies in Psychology and Pedagogy*, and *Investigations of the Department of Psychology and Education of the University of Colorado.*

The educational applications of the subject have found their chief outlet in *The Educational Review* (founded in 1891) and *The Pedagogical Seminary* (founded in 1891), in which numerous special and general articles have appeared from time to time. For the present survey I deem it hardly necessary to detail the avenues of publication of psychological material to be found in the medical, physiological and biological periodicals. The work done in abnormal psychology is also omitted in this review.

In lieu of having prepared a definite statistical statement of fact respecting the scope of the mass of literature thus variously appearing and which is steadily growing, and thereby being able to specify the exact items in psychology which have been the successive objects of a possibly shifting interest, I offer a sketch of these considerations made by naming the first and the last original articles appearing in each volume of the two technical periodicals published in this country. This method of marking off the years has the added benefit of the counter-checking due to the multiple editorial selection of the important and the less important material available, which is apt to maintain a fairly reliable average of values. The titles are given in the following order: The first and the last titles of a volume of the *American Journal of Psychology,* with its years, are first stated; then the respective titles of a volume of the *Psychological Review,* with its year—omitting in the latter instance the presidential addresses before our association when they chance to be the leading article, in which case the second article is taken.

'Disturbance of attention during simple mental processes,' 'National destruction and construction in France as seen in modern literature and in the Neo-Christian movement' (1892–1893), 'The case of John Bunyan,' 'An experimental study of memory' (1894), 'Syllabus of lectures on the psychology of pain and pleasure,' 'A laboratory course in physiological psychology: the visual perception of space' (1893–1895), 'H. von Helmholtz and the new psychology,' 'The perception of two points not the space-threshold' (1895), 'Experiments on Fechner's Paradoxen,' 'Attention experimental and critical' (1895–1896), 'Psychology and physiology,' 'Physical and mental measurements of the students of Columbia University' (1896), 'Attention and distraction,' 'The psycho-physiology of the moral imperative' (1896–1897), 'Studies in the physiology and psychology of the telegraphic language,' 'After-sensations of touch' (1897), 'The psychology of tickling, laughing, and the comic,' 'On choice' (1897–1898), 'Some effects of size on judgments of weight,' 'A mirror pseudoscope and the limit of visible depth' (1898), 'The migratory impulse vs. love of home,' 'A study of anger' (1898–1899), 'The relations between certain organic processes and consciousness,' 'A plea for soul-substance' (1899), 'The memory image and its qualitative fidelity,' 'Pity' (1899–1900), 'Psychological atomism,' 'An illusion of length' (1900). 'Creeping and walking,' 'Fluctuation of the attention to musical tones' (1900–1901), 'The social individual,' 'Study of early memories' (1901), 'The relation of the fluctuations of judgments in the estimation of time intervals to vaso-motor waves,' 'Mental growth and decay' (1902), 'The world as mechanism,' 'Feeling and self-awareness' (1902).

Generalization upon these captions is impossible, and scarcely pertinent. These thirty-six themes show a variation in interest rather than a steady development from a lower, narrower to a higher, broader

sphere. They show that interest in fundamental processes continued steadily, while time has been found for the more rare and exceptional activities of mind. More than half of them are experimental in character, in the severest sense of that term. The specialized tendencies of our psychological thinking appear, unquestionably, in such a sketch of the work which has been made the common property of the science.

The foregoing account of our psychological activities is admittedly limited. The best statement of the ten years that could be made would comprise a digest of the revised content in method, results and criticism which the succeeding years have brought forth. Such annual revision has doubtless taken place more or less throughout the entire field cultivated by us; for, as one of our iconoclastic members once said, no discovery in psychology is ever more than four months old. A second-best means to bring out the decennial features would be the exhibition of the annual changes by condensed and pointed statements descriptive of them. The fully capable surveyor might, perhaps, discover that there have not been ten ascending or cresting psychological interests. Instead of undertaking either of such accounts, some of the events and emphatic features of the decennium may receive descriptive presentation as follows:

The year of the beginning of our association, 1892, was a year of unusual interest, both at home and abroad. It marked what might well be called the 'psychological revival,' which deepened and perpetuated itself in institutional and extra-institutional organization. A dozen pages of 'Letters and Notes' in the April issue of the *American Journal of Psychology* ought to be transcribed in order to show the intensification of effort on all sides in the interest of psychological thinking, teaching and investigation. In August the second international Congress of Experimental Psychology (called 'experimental' the first time) was held in London, and Harvard University emphatically internationalized psychology among us by bringing Professor Münsterberg over the waters as the director of its psychological laboratory.

The year 1893 proved even more interesting historically. The first attempt in history to show internationally psychology in working order was made with the exhibit of experimental psychology, arranged by Professor Jastrow under the generous wings of anthropology, at the World's Columbian Exposition at Chicago. Here psychology was prepared in visual terms, being nothing less than a laboratory in operation, both as an exhibit and as a place for making 'tests.' Special mention should also be made of the significant congresses of rational psychology and of experimental psychology in education held during the exposition as part of the International Congress of Education under the charge of the National Educational Association of the United States. With but two exceptions in the experimental section, all the material presented before the two congresses came from our American students of the subject. The enthusiasm and attendance were rather unique. The same year witnessed a growing change of interest from the analysis of the mental states of the individual adult mind to the quest for the psychological roots of consciousness as these may be found in the psychical phenomena of the child and the lower animals.

For the cresting of a widespread popular interest in our science and its practical applications, the year 1894 will probably always stand out as remarkable. It was the great year of the formation of state

societies for stimulating and directing child study among teachers and parents. The American passion for novelty almost universalizes itself in the newer passion for collecting data and spreading the syllabus of inquiry. The National Educational Association had a new 'Committee on Psychological Inquiry,' which made its first report. The new theme of 'imitation' was so diligently pursued by psychologists, sociologists and educationists that they came near concluding that man is nothing else than an imitator. At least this process was regarded as the organizing function in the individual, enabling him to become a social unit. Our psychologists also seemed to take unusual delight in talking and writing about 'pain.'

The next year displayed a disturbance in the general feeling of confidence which had well settled down upon the cohorts of the psychologists. Some philosophers continued to deplore the transition of psychology into the state of a science, its adoption of exact methods in gathering accredited facts, etc. There appeared a strong reaction against the enthusiasm of the previous decade, and a decided doubt arose as to both the psychological character and the scientific value of the newer facts brought to light. These had received the name of the 'new' psychology, and it had to pass through the double baptism of fire and of praise as it was being steadily contrasted with the 'old' science. This reaction was doubtless the great crisis in the whole movement. Within the circle of psychologists this year was noteworthy by reason of more serious attention being given to that readjustment of methods and problems made necessary by bringing the great scheme of evolution up to the field of consciousness. The former physiological handmaid of the science was being surely replaced by her biological successor more effectively than ever before.

In 1896 several of the more important laboratories were moving into larger and better equipped quarters or were planning more space. Experimental activities were increasing. The popular magazines were giving unusual space to articles on psychology.

The year 1898 proved to be one of concentration, consternation and the experimental construction of the newer department of comparative or animal psychology. Those who held to the newer faith through the crisis of 1895 were moving forward constructively. Numerous articles on the arrangement and equipment of laboratories appeared. The problem of an 'individual' psychology attracted synthetic attention—not independently of foreign inquiries. Schemes of decisive tests were devised. Efforts began to be made to correlate all tests and measurements so as to sketch definitely the make-up of the normal mind, both in the formative and in the maturing ages. Certain complex functional activities involved in growth and in schooling were selected for careful analysis and patient investigation. And our late president recommended the introduction of 'the consulting psychologist' as the newest official in our educational system. But the practical applications of such and all other experimental results began at once to be seriously questioned by a large section of the educational public. This was but an echo of the warning note sounded by one of our members crying out against the dangers, not to say the absurdity, of an applied psychology. It is to be hoped that our science has fully regained by this time what was then so suddenly lost in general esteem, and as a useless sacrifice. Careful psychological experiments upon animals began to be made in several quarters, mark-

ing the tendency to develop this border province of the science. Out of this tendency, well stimulated in individual instances in previous years, has come a perfection and an extension of the more specific and exact modes of experimentation which prepared the way for the most satisfactory era of a definite comparative psychology, and a wider dependence upon the conceptions underlying a thoroughgoing application of the genetic method.

Of the unspoken years I am unable to specify accentuated activities, so even must have been the tenor of their way. Nor can one with ease put his finger upon the date of the introduction of the scientific method in those lines of interest in religion, in esthetics and in other higher manifestations of mind, which are enabling us to give a truer picture of the life-history of the soul, and which are now so well marked in their developments.

The decennium is also distinguished by the literary freedom and activity exhibited by our writers of treatises and text-books. I have not made it a part of my task to collect a summary of all the material available in this direction, but remained satisfied with an enumeration of some of the more important works which have appeared and which show in a different way the drift of the tendencies among us. In 1893 appeared Miss Shinn's 'Notes on the Development of a Child' (parts 1 and 2) and Tracy's 'The Psychology of Childhood.' The year 1894 saw the appearance of Ladd's 'Psychology Descriptive and Explanatory' and Marshall's 'Pain, Pleasure, and Æsthetics.' The first issue of 'The Psychological Index' was in 1895. It contained 1,312 entries, representing chiefly the bibliography, for the year preceding, of the literature of psychology and cognate subjects. Its latest issue, No. 8, for the year 1901, entered 2,985 titles. The following books also show the marked features of this year: Donaldson's 'The Growth of the Brain,' Stanley's 'Studies in the Evolutionary Psychology of Feelings' and Baldwin's 'Mental Development in the Child and the Race,' which was the beginning of a series of characteristic studies only now completing themselves. Ladd's 'Philosophy of Mind,' though treating of ultra-psychological questions, may also be mentioned as completing a unique trilogy on the soul. The year 1896 was fruitful in the following ways: Cope's 'The Primary Factors of Organic Evolution' had great value for the psychologist's problem of consciousness in evolution. The growing problems of social psychology received marked contributions in the work of Giddings, 'The Principles of Sociology.' And Baldwin's 'Dictionary of Philosophy and Psychology,' announced in this year, was expected to be ready in the following year. Even now the project is only two thirds completed. Scripture's 'The New Psychology' appeared in 1897. Throughout the decennium almost half a score of text-books for the subject have been prepared for class-room use, but the year 1898 might be called the year of psychological primers, by reason of the fact that two such books appeared. The same year saw a most interesting piece of pioneer work in the appearance of Sanford's 'A Course in Experimental Psychology, Part. I., Sensation and Perception.' In 1899 Starbuck gave completer form to his 'Psychology of Religion.' 1901 was a year unusually well marked by the appearance of the first volume of the 'Dictionary of Philosophy and Psychology' (though including the work of many hands not American) and Titchener's 'Experimental Psychology: A Manual of Laboratory Practice.'

The enrichment of American psychology through the translation of foreign works

into English should not pass unnoted, even with the briefest mention. Before the decennium began, we had Ribot's 'German Psychology of To-day' (1886), besides his works on heredity, attention, memory, personality and will, Preyer's 'The Mind of the Child' (2 vols., 1888 and 1889) and Höffding's 'Outlines of Psychology' through English hands, not to mention numerous other writings less typical of the dominant interests of psychology among us.

Within the ten years we have had Preyer's 'Mental Development of the Child' (1893), Wundt's 'Lectures on Human and Animal Psychology' (1894), Külpe's 'Outlines of Psychology' and Ziehen's 'Introduction to Physiological Psychology' (1895), Wundt's 'Outlines of Psychology' and Ribot's 'Psychology of the Emotions' (1897) and Groos's 'The Play of Animals' (1898) and 'The Play of Man' (1901). Most of this enrichment has come through the labor of American scholars, and is, therefore, interesting as indicating a continuance of the double debt our psychological thinking and activity owe to the foreign cultivators of our field of science.

In this connection an injustice would be done to the topic we have been surveying should we not remind ourselves of the fact that the output of our American psychologists has found place not only on the study shelves of our foreign brethren, but that also some of it has been transferred into the French, German and Italian languages. The following instances of such translations occur to me, but I can not say that the list is complete. Baldwin's 'Mental Development of the Child and the Race' appeared in French and German in 1896, his 'Social Interpretations' in 1899, his 'Story of the Mind' in French and Italian in 1899. James' 'The Will to Believe, etc.,' was translated into German in 1899, and his 'The Principles of Psychology' into Italian in 1900. Sanford's 'Course in Experimental Psychology' was translated into French in 1900, and a volume of Hall's studies has recently appeared in Germany under the title of 'Ausgewählte Beiträge zur Kinderpsychologie und Pädagogik.'

For our historical purposes it has been convenient to follow the lines of division between the activity within and the activity without the association. It is readily seen, however, that the widening interests of associational efforts, both individual and corporate, have been growing to include more and more of those achievements which we have reviewed as extra-associational. It is not possible, nor is it especially desirable, to give a quantitative statement of the claims the association may have upon this broader field. The healthy extension of its influences, though limited, is the fact to be noted. In how far it may be desirable that our psychology of the next ten years should be associational rather than individual is a question of development too large for the concluding words for which we have space.

One can not be truly historical without becoming prophetic. The prophecy may lie in inert words, lacking the momentum of a vigorous inspiration. In looking forward to the psychology that is to be among us, there are many means which I should like to point out as available by our association for the realization of certain desirable developments of our science both within and without. Its representation in our universities, colleges and secondary schools, the methods of teaching it to learners, of establishing its integrity more securely, and of extending its borders by investigations, and the specific contributions it has to offer to the welfare of the individual and of society, constitute the heart of vital problems which must come

more and more into the deliberations of our organization as a national court of appeal in such issues. The association truly has a solemn duty to perform in keeping in touch with the changing social and educational conditions in our national life and in seeing to it that the interests of psychology are adjusted to them. In spite of the experimental showing made in our statistical studies above, somewhere answer must be found for the questions persistently raised by the fact that the laboratory of psychology has not held its men like the other types of laboratory developed by science.

All these and several other vital questions relating to the efficiency of the association must be passed over to give place for a final suggestion. I doubt whether any person outside the council ever reads the reports dutifully presented by the treasurer. At the close of ten years we are in possession of a fund of some sixteen hundred dollars. The current expenses of the organization being kept reduced to a nominal minimum, the fund receives at the present rate an annual accumulation of nearly four hundred dollars. Should this rate of increase continue, the fund will be almost doubled in four years. Herein the association finds itself happily invested with both an obligation and an opportunity. This fund should be so administered as to yield the most stimulating returns in influence upon the growth of our science, especially in America. This can be done, not by burying or dissipating it in minor projects, worthy perhaps in their way and for the time being, but only by aiming high. The best effort the association can make seems to me to lie in the direction of establishing a *Prize Gold Medal in psychology*—a suggestion for which I take pleasure in thanking our president. The interest income of our fund four years hence would be sufficient to warrant the awarding of the medal every three years, or four at most. This medal should be awarded by the association only for the best piece of work done in psychology, either in research or in some other specific mode of advancing its multiple interests. The association might control the direction of the immediately future psychological thinking by setting a prize problem, or it might stimulate general efficiency on the part of psychologists by selecting the best work in unspecified lines for the high honor going with the medal distinction. The field of competition might be restricted to American psychologists, or left open to the world. This prize gold medal might even be designated by the honored name of some past or present American psychologist. But my suggestion does not include a draft of rules regulating the award of the medal. It remains for me only to express my deep conviction that more enthusiasm and inspiration would be infused into American psychology through such a foundation, which is perfectly possible, than through any other detailed project that could be suggested at the present time. Its great virtue resides in the fact that it would keep each worker looking forward and upward, and that through it the association would do a thing of great and lasting moment.

EDWARD FRANKLIN BUCHNER.
UNIVERSITY OF ALABAMA.

SCIENTIFIC BOOKS.

Standard Polyphase Apparatus and Systems. By MAURICE A. OUDIN. Third edition, revised. New York, D. Van Nostrand Company. Crown 8vo. Pp. 289. $3.00.

Students of electrical engineering have welcomed this up-to-date revision of Oudin's book on polyphase machinery, covering, as it

does in a very satisfactory manner, the chief features of the most recent developments in electrical engineering.

Chapter I. is devoted to definitions of terms and Chapters XII., XIII. and XIV. are devoted to the more or less theoretical questions of choice of frequency, weights of copper for various systems and calculation of transmission lines. The remaining chapters II. to XI. are devoted to the details of structure and operation of alternating current machinery of the polyphase type; and in an appendix is given the full report of the committee on standardization (of electrical machinery) of the American Institute of Electrical Engineers.

The author gives expression in his preface to a statement which has been current among electrical engineers for some time, namely that the most progressive engineering work of the day is that of switchboard design. The truth of this statement may be realized if we remember that the switchboard in a station includes all the controlling, regulating and safety devices, and that with the coming of our enormously powerful high-voltage generators the switchboard designer faces some of the most perplexing problems that have ever confronted electrical engineers.

W. S. Franklin.

Arithmetic of Electrical Measurements. By W. R. P. Hobbs. Ninth edition, revised by Richard Wormell. London, Thomas Murby. 1902. Crown 8vo. Pp. 112. 50 cents.

This is an excellent collection of simple problems illustrating the principles of current electricity. The problems are arranged in thirteen chapters and at the beginning of each chapter is given a series of explanatory paragraphs. An undue proportion of the problems are devoted to battery calculations such as grow out of series and parallel connections, while many important phases of modern electrical engineering are wholly untouched.

W. S. Franklin.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for June contains the first instalment of an article on 'The Colors of Northern Gamopetalous Flowers,' John H. Lowell; this is devoted mainly to a presentation of the character and colors of the flowers of the various orders of the group, though at the close we have a hint that bees have been largely instrumental in bringing about the survival of certain colored flowers. J. H. Powers discusses 'The Causes of Acceleration and Retardation in the Metamorphosis of *Amblystoma tigrinum*,' bringing forward a number of facts to show that the chief factor in change is a reduction in the food supply and not an insufficient supply of water for respiration by gills. Bradley Moore Davis considers at some length 'The Origin of the Sporophyte' and the balance of the number is devoted to notes and reviews.

The Popular Science Monthly for August opens with an article by Sir Oliver Lodge, on 'Modern Views on Matter,' the Romanes Lecture at Oxford; David Starr Jordan considers 'The Training of a Physician' and W. LeConte Stevens 'American Titles and Distinctions,' implying that here they are all too cheap. C. C. Nutting describes, with the aid of illustrations, 'The Bird Rookeries on the Island of Laysan'; Albert Schneider discusses 'Bacteria in Modern Agriculture,' showing what it is hoped to do by the aid of bacteria rather than what has actually been accomplished; and J. E. G. de Montmorency gives the second part of 'The Story of English Education,' bringing the subject down to date. Frederick A. Bushee has an article on 'The Declining Birth Rate and its Cause,' and J. A. Fleming the third instalment of a paper on 'Hertzian Wave Wireless Telegraphy.' There are many matters of interest discussed in 'The Progress of Science.'

The Museums Journal of Great Britain for June brings to a close the second volume of this valuable periodical, which comprises some 375 pages, besides the full index, and supplementary pages devoted to a directory of the Museums of Great Britain. Mr. Hoyle is to be complimented on the regularity with which the *Journal* has appeared and congratulated on the fact that he has made it a financial success.

With the July number *The American Museum Journal* begins its appearance as a quarterly. The leading article, illustrated, is on 'Martinique and St. Vincent Revisited,' by E. O. Hovey. Accessions are noted in various departments as well as the complete rearrangement of the halls of vertebrate paleontology on the alcove system, so that the attention of the visitor is concentrated on a given group. In connection with forthcoming improvements it is announced that two assembly rooms will be provided for the use of scientific societies. The supplement to the number, 'Guide Leaflet No. 11,' is devoted to a description of 'The Musical Instruments of the Incas,' by Charles W. Mead.

Bird-lore for July–August contains articles on 'The Bird Life of Cobbs' Island,' by Frank M. Chapman; 'In the Haunts of New Zealand Birds,' by Charles Keeler; 'The Loggerhead Shrike in Massachusetts,' by Jane Atherton Wright; 'System in Field Records,' by Eugene Murray-Aaron and 'Some Notes on the Psychology of Birds,' by C. William Beebe. There are the usual notes and reviews, and among the illustrations the fifth series of portraits of *Bird-Lore's* Advisory Councilors.

DISCUSSION AND CORRESPONDENCE.

ADDITIONAL FACTS CONCERNING THE BATH FURNACE METEORIC FALL OF NOVEMBER 15, 1902.

To the Editor of Science: Since the announcement concerning Bath Furnace Aerolite No. 1, which appeared in Science of January 16, two other pieces have been found; one picked up within one hundred yards of where No. 1 fell, and the other one three fourth mile south of this. Named in the order in which they have been found, we have designated these as No. 2 and No. 3, respectively.

No. 2 weighed 223 grams. It was completely coated with the black enamel or varnish and pitted. It has been sawed into two pieces: one for the Field Columbian Museum and the other for the Kentucky State College Museum. It has the same specific gravity and presents the same interior appearance as Bath Furnace No. 1.

No. 3, found about the middle of May last, by a hunter who was led to search for it by noticing a skinned place some distance up on a white oak sapling, will weigh about 200 pounds. It is also completely coated with the black enamel, and is very characteristically pitted and furrowed. These furrows radiate from a smooth nose or boss. It was this portion which bruised its way downward into the base and roots of the tree. The side opposite to this is flat and not furrowed nor pitted, but presents a few nodular excrescences.

As a result of visiting the locality, examining the places where the pieces struck and securing the accounts of the residents, all of whom were much startled by the blinding light and terrific detonations accompanying the fall, I gather the following: There was probably one mass originally, which burst at a height of from eight to nine miles into many fragments. These fragments struck the earth in a district some four miles square, situated in the knobs of the extreme southern portion of Bath County. Most of the region is thinly populated. No. 3 was found almost in the center of this thinly populated district. The accounts given by the residents of the noise made by the 'explosion,' of the singing of the fragments as they hurtled through the air, and the sound made by their striking the ground or hitting the timber on the knobs, were very graphic.

No. 3, which is probably the main portion of the original mass, has left some record from which possibly the trajectory of this celestial body may be computed. From the way in which it grazed the sapling in its descent, and bruised its way into the roots of the tree at the base of which it was found, I estimate that it came in from a direction 13 degrees south of west, and at an angle from the horizontal of 77 degrees. As previously announced, the altitude of the point of the bursting of the meteor, as seen from Lexington, was 9 degrees and 30 minutes. The azimuth of this point is N. 81 degrees E. The point of fall, however, plots out on

the map almost due east of Lexington, and distant 51 miles.

Two other saplings in the vicinity of where No. 3 fell, distant, respectively, about 100 and 200 yards, in an easterly direction, have been broken off by missiles striking them from the west. Search for where these buried themselves in the ground was not rewarded with success.

The dent in the road made by No. 1 had become obliterated, but from the accounts of those who saw it soon after it was made, it dipped eastward, and so is in line with the evidence afforded by the other fragments.

ARTHUR M. MILLER.

STATE COLLEGE OF KENTUCKY.

THE PROTECTIVE FUNCTION OF RAPHIDES.

TO THE EDITOR OF SCIENCE: In view of Dr. Wiley's interesting account (printed in SCIENCE of July 24) of the raphides of *Colocasia antiquorum*, it may be worth while to quote the description of these crystals and the cells containing them given by Haberlandt in his 'Physiologische Pflanzenanatomie,' edition 2, pp. 448, 449, 1896, translating literally:

"That in numerous cases the crystals of calcium oxalate, when they occur as raphides or spear-shaped crystals, are also to be regarded as functioning secondarily as a mechanical means of protection against animals that would feed upon the plant, is beyond doubt. Schroff has proved that the irritating effect of the sap of the bulb of *Scilla maritima* depends upon the penetration of the skin by the raphides, and that filtered sap produces no irritation. Stahl * afterwards demonstrated the same thing as holding true for other plants, especially *Arum maculatum*, and showed by experiment that leaves of that plant, when merely treated with alcohol, were hardly touched by snails, while on the other hand, leaves treated with dilute hydrochloric acid, in which the raphides were dissolved, were very quickly devoured. The ejection of the numerous crystal needles from the cell containing them is largely effected through the absorption of water by the strongly swelling mucilaginous substance which always encloses the bundle of raphides. That the form of the containing cell, as well as the manner in which its walls are thickened, is in many cases an adaptation to the protective function of the raphides, is indicated by the following example.

"In the leaves of *Pistia Stratiotes* [which like *Colocasia* and *Arisæma* belongs to the Arum family], the one-layered plates of parenchyma that make up the aerenchyma (breathing tissue) contain transversely placed, spindle-shaped, elongated cells [almost cigar-shaped in Haberlandt's figure] containing raphides. Both ends of these cells project into the intercellular air spaces. The blunt ends of these cells have an extremely delicate cell wall, while the rest of the cell wall is rather thick, although not cutinized. Upon mechanical injury to the cell, although not, however, through the simple presence of water, the raphides are ejected, generally one at a time, with considerable force through the swelling mucilaginous envelope, whereby the thin portion of the cell wall is pierced and soon completely disappears. The place of exit of the raphides is in this case determined by the thin part of the wall and, furthermore, the conical tapering of the ends of the cells prevents the whole bundle of raphides being ejected at once. As the raphides are projected one after the other, the attacking animal can be wounded in different parts of the body."

THOS. H. KEARNEY.

* The utility of raphides in protecting plants from snails is quite fully discussed by Stahl in his interesting paper entitled 'Pflanzen und Schnecken: Eine biologische Studie über die Schutzmittel der Pflanzen gegen Schneckenfrass,' *Jenaischen Zeitschrift für Naturw. und Med.*, Vol. 22, pp. 84–99 of the reprint.

SHORTER ARTICLES.

CARBONIFEROUS FOSSILS IN 'OCOEE' SLATES IN ALABAMA.

THE age of the semi-crystalline and crystalline schists which extend in continuous belt from New England to Alabama, has long been a subject of discussion and of wide difference of opinion among geologists. On the one hand, they have been considered as pre-Cambrian;

on the other, they have been identified as metamorphosed Paleozoic sediments. At the northern end of this belt it has been possible, by means of the fossils, by tracing them into unaltered fossiliferous beds, and by their stratigraphic relations, to assign parts of these slates to Paleozoic formations. Thus the 'Archæan' of southeastern New York has been proved to be largely of Cambrian and Ordovician age, and the highly crystalline mica schists of New York island are now assigned to the Hudson river horizon. Further southward in Pennsylvania and Maryland a similar change in the reference seems to be taking place, as is evidenced by the recent work of Miss Bascom.

The semi-metamorphic slates and conglomerates constituting the Ocoee of Dr. Safford have in like manner been variously classified. Dr. Safford considered them as of Silurian (Cambrian) age, but as occupying a position below the oldest of his fossiliferous Silurian divisions, the Chilhowee. Mr. Arthur Keith at one time, from their superposition and structure, reached the conclusion that these rocks were in part at least of Carboniferous age, but detailed mapping and study of the sedimentary formations of the North-Carolina-Tennessee mountains and the tracing of the different layers from place to place, have enabled him to prove to the satisfaction of the geologists conversant with that region that the Ocoee strata along or near the state boundary line are of Cambrian age, and correspond in the main to the lower part of the section shown in Chilhowee Mountain. In this he confirms Dr. Safford.

Mr. E. C. Eckel, in papers * dealing with the gold deposits of the Dahlonega district of Georgia, has suggested incidentally that both the Ocoee rocks proper and the more highly metamorphosed rocks east of them are probably of Paleozoic age, and may possibly be in part of late Paleozoic age; while the Dahlonega gold deposits were certainly formed not earlier than the Ordovician and possibly as late as the Carboniferous. These conclusions were based upon the structural relations of the deposits, and were supported by analogy with similar rocks and deposits in Tennessee, Virginia and New York.

From these notes it will appear that conclusions as to the age of the Ocoee have heretofore been based upon their stratigraphy and structure, *i. e.*, upon circumstantial evidence, and it will, no doubt, be of interest to readers of Science to know that we have now *definite paleontological evidence* of the age of a part, at least, of these rocks.

In November, 1902, I received from Mr. Joshua Franklin, of Mosely, Clay County, Ala., some fossils obtained by him from the slates near his house. These were submitted to Mr. David White, of the National Museum, for identification, but it was not until May of the present year that I had the opportunity of visiting the locality and noting the mode of occurrence of the fossils. The locality is at the eastern base of the main range of the Talladega Mountains and at a distance of eight miles or more from the contact of the 'Ocoee' with the unaltered Cambrian of the valley. The slates in which the fossils are found are the ordinary semi-crystalline (sericite) slates of the Ocoee type. At the point in question these slates are in places highly charged with graphitic matter, which is particularly in evidence in freshly exposed rocks in a railroad cut. Where they have been long exposed at the surface they have lost in great measure this graphitic matter and are of the usual bluish and yellowish colors and silky luster. The fossils are mostly found in concretions, usually lens-shaped, but occasionally longer in one dimension; the concretions are very perceptibly lighter in specific gravity than the rock itself; when broken open they are sometimes found to hold badly preserved organic forms; sometimes they are hollow, the organic matter having apparently been removed by decay, leaving only a loose powdery silicious residue filling only a part of the cavity. Other fossils, and among them the most perfect one (a *Lepidostrobus*), are found loose, and, while they have not yet been specifically identified, appear to be pieces of stems

* *Engineering and Mining Journal*, February 7, 1903; Bull. 213 U. S. Geol. Survey.

of *Lepidodendron, Calamites* and *Artisia.* Like the concretions, these fossils are generally considerably lighter in weight than the ordinary rock. It is interesting also to note that I found several thin veins of turquoise in the slates of the railroad cut above mentioned. The same mineral had been previously observed in thin veins in a much more highly crystalline mica schist a few miles distant from this locality. Mr. Franklin has also given me a piece of quartz showing free gold which he says he found in the same slates that carry the fossils, and indeed in the near vicinity of this find, precisely similar slates, to all appearance, carry quartz veins that have been worked for gold for many years. I collected the fossils along this belt of slates for a distance of a mile or more, and while they are not particularly abundant, I was able in the course of an hour to get fifty or more specimens.

Mr. David White, to whom the best specimens were sent, writes me as follows: "The fossils you sent me are most interesting and important on account of their bearing on the classification of the formation from which they were derived. The biological problem is hardly less interesting to me, for it is but the second lepidophytic cone fragment showing microscopical structure that has turned up in our Paleozoics, so far as I am aware. Another larger specimen in hand is from a Carboniferous limestone in the Indian Territory. Your specimens represent several fragments of large cones in which the axes, the basal, sporangiferous portions of the spirally arranged bracts, the rhomboidal compressed sporangia and the megaspores are well defined. Precise identification of the material is deferred pending the study of thin sections and the determination of certain points regarding the sporangial walls and their attachment to the basal portions of the bracts. It is clear, however, that we have here fragments of cones whose superficial features appear to represent the common *Lepidostrobus* type of the upper Paleozoic. Beds containing lepidophytic remains of this type can hardly be older than Devonian at earliest, and should not antedate the Middle Devonian.

"The general proportions and aspect of the cones are suggestive of some of the Carboniferous forms. Although the internal structure of the strobili may be found to indicate a more highly organized genus than *Lepidostrobus,* we may rest assured that the material is not older than the Upper Paleozoic lepidophytes."

We can now safely say that the Ocoee of Alabama includes the metamorphosed sediments of more than one of the Paleozoic formations, but it may be doubted if conclusive paleontological evidence of the age will be found in many cases, since the fossils will inevitably be obliterated in all the more highly crystalline of these schists.

Eugene A. Smith.
University of Alabama,
June 6, 1903.

BOTANICAL NOTES.

TWO INTERESTING PARASITIC PLANTS.

In a recent bulletin of the Kentucky Experiment Station, Professor Garman describes two parasitic plants which are considerably out of the ordinary line. They are the broomrapes of the genus *Orobanche.* They are small plants related to the figworts, but destitute of any green color. Their roots are attached to the roots of various plants, and in this way they steal the food matters which, were they honest, they would secure for themselves from the soil and air. The first species described, *O. ramosa,* is parasitic to a considerable extent on tobacco and hemp in Kentucky, doing a good deal of damage. The second is *O. ludoviciana,* a native species very common on the western plains. This is also found to be parasitic on the hemp in Kentucky. These two species have been carefully investigated by Professor Garman, and he makes some suggestions in regard to their eradication. He finds that is impracticable to remove the parasites from the growing crop of hemp, but it is practicable to remove them from the tobacco crop. It is found impracticable to remove the rape seeds from hemp seed by flotation. Soak-

ing the hemp seed in bluestone solution will kill the rape seeds, but not the hemp. Water heated to 140° F. appears not to hurt hemp seeds, but the rape seeds are destroyed by this temperature. It is found that the rape seeds maintain their vitality for at least thirteen years in the soil. Professor Garman insists upon it that by the use of improved machinery the rape seeds may be largely removed from the hemp seed. The application of lime, salt, etc., to the soil is found to have no value.

THE STUDY OF GALLS.

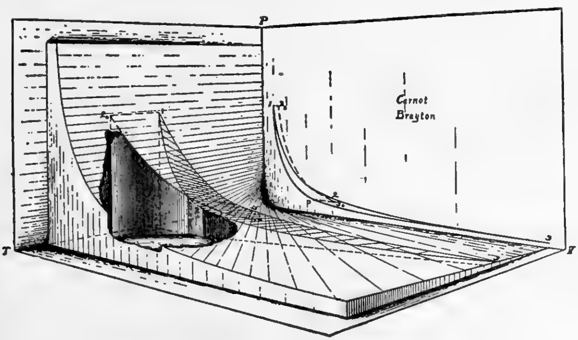
SOME time ago a notice was made in these columns of a book of Edward Connold, of England, entitled 'British Vegetable Galls,' and the suggestion was made that in America this field of inquiry is practically uninvaded. We are glad to know that Professor M. T. Cook, of DePauw University, has been giving attention to these structures for some time. We have before us two bulletins issued by the Ohio State University devoted to 'Galls, and Insects Producing Them,' by Professor Cook. This article is a preliminary publication which promises a much more extended publication in the future. The article as at present published includes 'Morphology of Leaf Galls,' 'Apical Bud Galls,' 'Lateral Bud Galls,' 'Stem Galls' and 'Development of Galls.' It is the intention of Professor Cook to continue this work, enlarging the scope of his inquiries until he has material enough for an extended publication. We may, therefore, confidently expect an American volume comparable to Connold's British volume referred to above.

CHARLES E. BESSEY.

UNIVERSITY OF NEBRASKA.

'*GRAPHICS OF THERMODYNAMICS.*'

MESSRS. BATES AND WELBORN, in the *Sibley Journal of Engineering,* present an interesting study of the relations of five gas-engine type-cycles and graphically exhibit their characteristics in three-dimension diagrams which strikingly illustrate the text.* A common compression line is assumed and the same amount of work is performed by each cycle; all performing similar work with similar heat-supply, under these conditions, as indicated by Röntgen's theorem.



Characteristics of Cycles.

All heat-engines employing a perfect gas as working substance, in a cycle composed of a pair of adiabatics crossed by a pair of isodia-

* *Sibley Journal of Mechanical Engineering,* June, 1903, p. 372. *Vide* 'Thermal Lines on Isometric Planes,' *Sibley Journal,* February, 1900, by R. H. T.; 'Graphic Diagrams and Glyptic Models,' *Jour. Franklin Inst.,* January, 1896, by R. H. T.

batics, have the efficiency $(T_1 - T_0)/T_1$, where T_1 and T_0 are the temperatures of the terminals of the compression line.

Adopting the methods of the writer, the following data are obtained.*

CHARACTERISTICS OF TYPE-CYCLES.

	Absolute Pressure Lbs. per sq. in.				Absolute Temperature.			
	p_0	p_1	p_2	p_3	T_0	T_1	T_2	T_3
Carnot	15	115	23.8	3.11	520	931	931	520
Otto	15	115	188.3	24.5	520	931	1522.7	852
Brayton	15	115	115	15	520	931	1352.7	755
Ericsson	15	72.3	72.3	15	520	520	931	931
Stirling	15	72.3	133	27	520	520	931	931

	Volumes.				Maximum Pressure.	Maximum Temperature.	Maximum Volume.
	V_0	V_1	V_2	V_3			
Carnot	1	.2334	1.125	4.82	115	931	4.83
Otto	1	.2334	.233	1	188.3	1522.7	1.00
Brayton	1	.2334	.338	1.45	115	1352.7	1.45
Ericsson	1	.207	.372	1.79	73	931	1.00
Stirling	1	.207	.207	1	130	931	1.80

The characteristics of the several cycles are displayed graphically in the usual manner on pressure-volume, on temperature-volume, and on temperature-entropy planes, all of which bring out very clearly the distinctions indicated by the tabulated data; the principal being the great volume of the working cylinder for the Carnot cycle, the comparatively large pressures of the Otto—the Beau de Rochas—and the low pressures of the Ericsson diagram. The Carnot cycle is thought impracticable on account of engine volume, weight and cost; the Beau de Rochas involves very high temperatures and pressures and the Ericsson and Stirling engines seem likely to waste largely by dissipation of heat.

"The Brayton, on the whole, seems to promise best and, while practical obstacles modify any application, it yet remains true that recent reports would seem to place engines operating in this cycle in the lead."

The most novel and perhaps immediately interesting feature of the paper is its illustrations of the cycles discussed by forms in relief. The accompanying engraving is an illustration of one of these—a comparison of the Carnot and the Brayton cycles, referring co-ordinates to pressure, volume and temperature planes. The two cycles are seen in usual form on the p-v plane and their respective diagrams are indicated throughout the figure by full lines for the Carnot, dotted lines for Brayton. The numerals 1 and 1_0, 2 and 2_0, 3 and 3_0, respectively, indicate the same distinction. The common initial point of the diagrams is seen at 0.

R. H. THURSTON.

*Manual of the Steam-Engine,' Vol. I., p. 418.

EXHIBIT OF THE U. S. NATIONAL MUSEUM AT ST. LOUIS.

THE most striking feature of the exhibit of the U. S. National Museum at St. Louis will be the reproduction of a full grown sulphur-bottom whale. The mold for this was obtained through the courtesy of the Cabot Steam Whaling Co. at their station at Balena, Newfoundland, and was made from one of the largest whales taken this summer; a skeleton of the same species was presented by the Colonial Manufacturing Co., of St. Johns, Newfoundland. As definite measures and weights of whales are not easily obtainable some details on these points may be of interest. The animal, a male, from which the skeleton was procured, measured 74 ft., 8 in. from the notch of the flukes to the tip of the nose, or 79 ft. from tip of flukes to tip of lower jaw. The girth around shoulders was 35 ft. and the width of the flukes 16 ft., 5 in. The skull, over all, measured 19 ft. and the width across

the orbits was 9 ft., 3 in.; the length of the jaws was 20 ft. along the outer curve, while the combined weight of cranium and jaws was four tons.

The approximate weight of a specimen of this size, as determined by Mr. S. C. Ruck, are as follows:

	Pounds.
Weight of bones	17,920
Weight of blubber	17,920
Weight of flesh	89,600
Weight of whalebone, including the attached gum	1,750
Weight of viscera and blood, estimated	13,440
Total	140,630

or not far from 63 tons. F. A. L.

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*MEMORIAL TO SIR WILLIAM FLOWER.**

My Lord Archbishop, Ladies and Gentlemen:

The late Sir William Flower, formerly director of this museum, was one of my oldest and most intimate friends. It was, therefore, with great pleasure that I agreed to the request of the Flower Memorial Committee to say a few words on the occasion of the presentation to the trustees of the bust of the late director.

The bust which, as you will presently see, so well represents the kindly countenance of our deceased friend, is the work of Mr. Thomas Brock, R.A., and no one, I think, will deny that the talented artist has achieved a remarkable success in producing it. But before formally presenting it I may venture to say a few words about him whose memory we seek to honor on the present occasion, and about the excellent scientific work which he performed.

Born in 1831, Flower was a member of a well-known family of Stratford-on-Avon, and, showing remarkable taste for natural history in his early youth, was educated for the medical profession. He graduated at the University of London in 1851 and became a member of the Royal College of Surgeons the same year. In 1852 he read a paper to the Zoological Society on the structure of a species of *Lemur,* the first of a long series of communications to that society which continued for forty-five years.

In 1854, on the Crimean War breaking out, Flower joined the Army Medical Staff, and was present at the battles of Alma, Balaclava and Inkerman, and at the capture of Sevastopool, and afterwards did good work in the British Hospital at Scutari, in acknowledgment of which he received the Crimean medals.

On returning to England, Flower quickly reverted to natural history, and in 1855 was appointed demonstrator of anatomy to the Middlesex Hospital and curator of its museum. Here he did excellent work, and so plainly showed the stuff that he was made of, that six years later, in 1861, on the death of Queckett, he was appointed conservator of the museum of the Royal College of Surgeons. This important post Flower held for twenty-two years and, as we all know, carried out its duties in a most effectual manner. When the president of the Royal Society delivered to Flower the Royal medal in 1882, he said: 'It is very largely due to Professor Flower's incessant and well-directed labors that the museum of the Royal College of Surgeons contains the most complete, the best ordered and the most accessible collection of materials for the study of vertebrate structure in existence.'

From 1870 to 1884 Flower was Hunterian professor of comparative anatomy and physiology, and gave the admirable courses of lectures on these subjects which have rendered his name famous in the annals of zoological science.

In 1879, on the death of Lord Tweeddale, Flower was unanimously elected president of the Zoological Society of London, upon the council of which he had served for many years previously, and retained this post until his death in 1899. In 1884 the directorship of the great Natural History Museum in which we are now assembled became vacant by the death of Professor Owen, and Flower, being *omnium consensu* most admirably fitted for it, was selected for the post. Of the way in which he performed the heavy duties of this

* Full text of Dr. Sclater's address on the occasion of the presentation of a bust of the late Sir William Flower to the trustees of the British Museum, July 25, 1902.

office it is quite unnecessary for me to speak to the present company. It must suffice to say that the whole of his time and all his great abilities were devoted to the performance of the multifarious business of this important position.

In 1899 Flower was president of the British Association at Newcastle-upon-Tyne, and devoted his presidential address mainly to museums and their arrangement. This was, no doubt, one of his favorite subjects, and Virchow, of Berlin, is said to have called him the 'Prince of Museum Directors.' Thus we see that Flower had occupied three of the most exalted and conspicuous posts that any devotee of zoology could hope to attain—the directorship of the Natural History Museum, the presidentship of the British Association and the presidentship of the Zoological Society of London. Besides this he was selected for the presidency of the International Congress of Zoologists which met at Cambridge in 1898, but the unfortunate failure of his health compelled him to surrender this last appointment.

In zoology, no doubt, Flower's chief subject was the class of mammals, and the work by which he will probably be best known to posterity is his volume entitled 'Mammals, Living and Extinct,' published in 1891, in which he was assisted by Mr. Lydekker. This admirable hand-book is, and will long remain, our standard work of reference for students of the class of mammals.

A distinguished writer has well said: "No comparative anatomist of recent times has more devotedly or with greater ability and accuracy studied mammals. Moreover, in every instance he has enlarged our knowledge by his acute and comprehensive views, and, since the range of his contributions passes from the monotremes to the primates his influence on the subject has been immense.

"The labors of his life culminated in the magnificent series of whales, which it was one of his last duties to arrange and exhibit in a remarkably ingenious manner.

"While a splendid series of mounted skins, models and skeletons themselves can be studied in the whale room numerous drawings and labels enable the visitor to grasp still further the form and structure of these gigantic denizens of the deep. No more fitting memorial of the skilful hand of the leading authority on the subject could be found than this marvelous and unique collection."

And no more fitting situation, I think, it will be generally acknowledged, could be found for the bust, which so well recalls the features of the deceased naturalist, than the whale room which he planned and furnished, and in which, I believe, it is proposed to place it.

My Lord Archbishop:

In the name and on behalf of the 185 subscribers to the 'Flower Memorial Fund' (which has received the generous support of the zoologists of nearly every part of the world) I beg leave to offer this bust for the acceptance of the trustees of the British Museum.

THE INTERNATIONAL COMMISSION OF ARCHEOLOGY AND ETHNOLOGY.

A movement promising to effect much in the way of stimulating scientific and historical research throughout the western hemisphere, and perhaps even more in the direction of bringing about close and more harmonious relations among the several American republics, was initiated at the second International American Conference in the City of Mexico in January, 1902. The first step was taken by Hon. Volney W. Foster, of Chicago, one of the representatives of the United States in the conference; with the cooperation of Señor Don Alfredo Chavero and others, he introduced a resolution providing for an International Commission of Archeology, which was adopted by the conference and recommended to the several participating countries in the volume of 'Recomendaciones, Resoluciones, Convenciones y Tratados,' issued later in the same year. The first of the American republics to take action in accordance with the recommendation of the conference was Mexico; in October last President Diaz appointed Señor Chavero as a representative on the part of the Mexican government to confer with similar representatives from other countries concerning procedure toward the organization of the commission. Dr. Chavero visited

Washington and New York during the Congress of Americanists later in the same month, and seized the opportunity to confer with the leading archeologists of the western hemisphere. Before returning to Mexico, he framed a plan in accordance with which the Mexican ambassador to the United States, His Excellency Señor Don Manuel de Aspiroz, was more formally appointed as a representative of the commission and empowered to treat with the diplomatic representatives of other American countries.

Meantime the movement attracted some attention in the United States; at meetings in Pittsburg early in July both the American Association for the Advancement of Science and the American Anthropological Association passed resolutions approving the general plans for the commission; and on November 13, our secretary of state, Hon. John Hay, appointed Dr. W J McGee as a representative on the part of the United States to confer with similar representatives from other American countries. Dr. McGee visited the City of Mexico, where he conferred with Señor Chavero and other officials interested in the project, including President Diaz; and after his return, he cooperated with Ambassador Aspiroz in developing a plan of organization for the commission.

On April 15, 1903, a meeting of the diplomatic representatives of the American republics was convoked in the State Department, at which the plan proposed by Messers. Aspiroz and McGee was formally adopted for transmittal to the several governments. Of these, six or seven had already taken favorable action; and it was the expressed desire of the meeting to obtain formal approval from the governments of the remaining republics.

The second article of the regulations in which the plan of organization of the commission is embodied provides:

The objects of the Commission shall be (1) to promote the unification of laws relating to antiquities in the Western Hemisphere; (2) to increase and diffuse knowledge concerning these antiquities and the aboriginal peoples by whom they were produced; (3) to awaken interest in the vestiges of a vanishing race; (4) to unify museum methods throughout the American countries, and (5) to work for the establishment of one or more archeologic and ethnologic museums of international character.

The third article provides that the Commission shall form an Administrative Corps and include a Scientific Corps.

The commission in its administrative capacity will consist of representatives officially designated by the participating governments to a number not exceeding three from each; the officers being a president, three vice-presidents and a secretary—all elected by the commissioners at stated sessions. The scientific corps will consist of scientists to the number of one or more from each participating country, and scientific attachés, the latter assigned to work so far as practicable in countries other than those in which they were trained. The officers of the scientific corps will be a director general and a secretary, with a director for each participating country; these officers will be nominated by the scientific corps and elected by the commissioners; and the plan provides for filling *ad interim* vacancies.

As a public office the commission will be maintained chiefly by appropriations in and for the participating countries on a basis corresponding with those made for the International Bureau of American Republics; but it is planned to utilize donations of service, collections, money and other values. In accordance with the original recommendation of the International Conference accounts will be kept in the Bureau of American Republics. Provision is made for stated sessions both of the scientific corps and of the commission in December of each year, and also for the publication of reports.

On April 20, Hon. W. W. Rockhill, director of the Bureau of American Republics, formally communicated the action of the diplomatic representatives to the several legations; while the representative of the United States reported progress to our secretary of state and recommended the appointment of the three commissioners provided for in the plan of organization. Action was soon taken on the recommendation, and the commissioners were

appointed. They are Hon. Volney W. Foster, the representative of the United States in the International Conference, to whose initiative the movement is due; Dr. W J McGee, president of the American Anthropological Association, long ethnologist-in-charge of the Bureau of American Ethnology, and now chief of the Department of Anthropology in the Louisiana Purchase Exposition; and Professor Francis W. Kelsey, of the University of Michigan, secretary of the Archeological Institute of America.

On August 7, the American commissioners met in Evanston with the object of studying the plan of organization and preparing themselves to meet their associates from other countries at the organizing session on the third Monday in December next. The plan of organization adopted at the meeting of the diplomatic representatives on April 15 was found acceptable in all its general provisions, though a few minor changes were suggested. Informal advices indicate that corresponding action has been taken in Mexico and two or three other American republics; so that the outlook for the organization seems promising.

SCIENTIFIC NOTES AND NEWS.

As we have already stated Professors Simon Newcomb, Hugo Münsterberg and Albion W. Small, the committee in charge of the Congress of Arts and Sciences of the Louisiana Purchase Exposition, are at present abroad making arrangements and issuing invitations in connection with the congress. Mr. Joseph B. Gilder writes to the Boston *Transcript* stating that more than sixty foreign delegates have accepted the invitation, including in mathematics, MM. J. G. Darboux, Émile Picard and J. H. Poincaré, of Paris; and Professor O. Boltzmann, of Vienna. In chemistry, Professors James Dewar, of London; W. Ostwald, of Leipzig; and J. H. Van't Hoff, of Berlin. In astronomy, Professors H. H. Turner, of Oxford; and W. Kapteyn, of Utrecht. In geology and mineralogy, Professors Ferdinand Zirkel, of Leipzig; C. Weigert, of Frankfort; and Sir Archibald Geikie and Dr. Hugh Robert Mill, of London. In biology, Professors K. Goebel, of Munich; Max Fürbringer, of Heidelberg; Felix Marchand, of Leipzig; Alfred M. Giard and L. Manouvrier, of Paris; and Wilhelm Waldeyer, Oskar Hertwig, Wilhelm Engelmann and Albert Orth, of Berlin. In psychology, Principal C. Lloyd Morgan, of Bristol; M. Pierre Janet, of Paris; Professors Herm. Ebbinghaus, of Breslau; and Carl Stumpf, of Berlin. In philosophy, Professors Henri Bergson, of Paris; Carl Dessoir, of Berlin; Alois Riehl, of Halle; Windelband, of Strasburg; and W. R. Sorley, of Cambridge, England.

THE vacancy on the board of trustees of the Elizabeth Thompson Science Fund, caused by the resignation of Dr. J. M. Crafts, has been filled by the election of Professor T. W. Richards, of Harvard University.

MR. R. LYDEKKER, F.R.S., has been elected a foreign member of the R. Accademia dei Lincei, Rome.

PROFESSOR GUIDO BACCELLI has been elected a corresponding member of the Paris Academy of Medicine, in the Section of Medicine and Surgery. Dr. Baccelli is the Italian minister of agriculture.

DR. JULIUS WIESNER, professor of botany at the University of Vienna, has been elected a corresponding member of the Academy of Sciences at Turin.

G. L. SWENDSEN, professor of civil engineering and hydraulic engineer to the Utah Agricultural College and Experiment Station, has resigned to accept an appointment with the U. S. Geological Survey.

PROFESSOR W. O. ATWATER, of Wesleyan University, is at present abroad and will remain until November, studying experiments there being made on human nutrition.

PROFESSOR GEO. F. ATKINSON, who holds the chair of botany at Cornell University, sailed for Europe last week.

DR. A. PETRUNKEVITSCH, docent for zoology at Freiberg, is about to visit America to carry on scientific work.

MR. W. C. WELBORN, formerly of the Mississippi Agricultural and Mechanical College,

has gone to the Philippines, to accept a position in the Bureau of Agriculture.

Nature states that Mr. W. R. Ogilvie-Grant, of the Natural History Museum, has returned from his trip to the Azores with a large collection of birds, insects and land molluscs, the latter including some forms of special interest.

LIEUTENANT KOLCHAK has started from the Arctic coast for the New Siberian Islands in search of Baron Toll, the head of the Russian polar expedition which left St. Petersburg three years ago.

A MEETING was held in Bar Harbor, Maine, on August 15, to confer with respect to the memorial in honor of the late Major Walter Reed, M.D., U.S.A., to whom the world is indebted for most important services in the investigation and the suppression of yellow fever. The meeting was called by President Daniel C. Gilman, Drs. S. Weir Mitchell, Edward G. Janeway, Wm. H. Welch and Christian A. Herter.

GENERAL E. E. BRYAN, a prominent lawyer of Wisconsin, for several years dean of the Wisconsin University Law School, died on August 11, at the age of sixty-eight years. At the time of his death he was president of the Commission of Fisheries for the State of Wisconsin, and president of the Commission for the Natural History and Geological Survey of the State.

M. PROSPER HENRY, since 1865 connected with the Paris Observatory, well-known for his work in celestial photography carried out in conjunction with his brother, M. Paul Henry, died in the French Alps on July 25, as a result of exposure to the cold.

M. ERNEST MENAULT, inspector general of agriculture in France and the author of numerous works on agriculture and economic entomology, has died at the age of seventy-two years.

DR. BACCIALLI has died as the result of an accidental inoculation while carrying on bacteriological investigations at Bologna.

WE regret also to record the deaths of Dr. Eduard Weyr, professor of mathematics at the Prague Technological Institute, who died on July 23, at the age of fifty years, and of Dr. Apollon Kurbatow, professor of applied chemistry at the St. Petersburg Technological Institute.

ACCORDING to an answer to a question in the House of Commons the sums voted for London museums and galleries for the current year are: Victoria and Albert Museum and Bethnal-green Museum, £66,994; Geological Museum, £3,558; British Museum, £128,729; Natural History Museum, £49,051; National Gallery, £18,600; National Portrait Gallery, £5,541; Wallace Collection, £9,066.

THE British Civil Service supplementary estimates include the sum of £45,000 for the relief expedition to be sent to the Antarctic.

THE daily papers state that the schooner *Marie Sachs,* sent by the California Academy of Sciences to explore the islands of the Pacific coast, has returned with numerous collections, after a voyage of four thousand miles.

ACCORDING to the New York *Evening Post* a scientific expedition, led by an American, Major W. C. Daniels, will leave Southampton on September 1 for New Guinea. Major Daniels will be accompanied by Dr. C. G. Seligman, a member of the Cambridge Anthropological expedition to Torres Strait and Sarawak, Borneo; Dr. William Strong, of Trinity College, Cambridge; and A. H. Dunning. Major Daniels has equipped a schooner, and the Royal Geographical Society has furnished the instruments. The Royal Society and the British government are helping the expedition financially. Ethnological, pathological, geographical and geological investigations will be made.

IT appears from an article in *Nature* that the arrangements for the Southport meeting of the British Association are well advanced. The meeting at Southport in 1883 was one of the most successful in the history of the Association, standing eighth in point of numbers and fourth in point of receipts, with 2,714 members in attendance. It is consequently hoped that the meeting this year will be larger and more interesting than usual. Evening lectures will be given by Dr. Robert Monroe

on 'Man as Artist and Sportsman in the Paleolithic Period,' and by Dr. Arthur Roe on 'The Old Chalk Sea and some of its Teachings,' while the evening lecture to working-men will be given by Dr. J. S. Flett on 'The Recent Volcanic Eruptions in the West Indies.' Americans returning home from summer holidays abroad will find Southport a very convenient place for the meeting, which begins on September 9.

At the meeting of the German Association of Men of Science and Physicians to be held at Cassel from September 20 to 26, general addresses are promised by Professor Ziehen of Utrecht, on the physiological psychology of the feelings and affections; by Dr. Griesbach of Muhlhausen, on the present condition of school hygiene; and by Professor von Behring of Marburg, on the struggle against tuberculosis.

The Congress of Alienists and Neurologists of France and French-speaking Countries held its thirteenth annual meeting at Brussels beginning August 1.

The twenty-fourth annual meeting of French Geographical and Colonial Societies was held this month in Rouen. According to the London *Times* twenty-four French geographical societies were represented, nine kindred societies, and three foreign geographical societies. The Royal Geographical Society was represented by Mr. H. J. Mackinder, director of the School of Geography at Oxford. Various French Ministries were also represented. The program was a long one, including about forty communications, many of them on questions of great importance and wide interest. On the conclusion of the congress a number of excursions were arranged for, about eighty of the members proposing to go to England.

The *British Medical Journal* gives some details in regard to the International Congress for the Study of Tuberculosis which will be held in Paris from September 24 to October 1, 1904. The congress will comprise a medical, a social and a technical section. In the medical section the following are the questions proposed for discussion: (1) The treatment of lupus by the new methods; (2) the early diagnosis of tuberculosis by the new methods; (3) comparative study of the different forms of tuberculosis. The social section will discuss the following questions: (1) The etiological factors of tuberculosis; (2) the value of the various methods of treating tuberculosis; (3) assurance and sickness societies in relation to the struggle against tuberculosis. The technical section consists of a museum in which will be exhibited collections of anatomo-pathological, histological and bacteriological specimens and preparations; tables of statistics, plans and designs for the installation of hospitals, sanatoria and dispensaries; publications of all kinds relative to antituberculosis leagues and associations; and industrial products used in the treatment of tuberculosis. The president of the congress is Professor Brouardel.

A difficult piece of topographic surveying has recently been completed in connection with the Uncompahgre Valley projects in western Colorado. In the course of the investigations it became necessary that a topographic survey should be made of about 1,500 feet of the bottom of the Grand Canyon of the Gunnison River. A general survey of this canyon was made last year by parties connected with the Reclamation Service, and the locality mentioned was selected as the point for the location of the head of a tunnel six miles in length to be constructed for the purpose of conducting water into the Uncompahgre Valley. The canyon at this point is approximately 2,000 feet in depth, the walls being sheer precipices. The water flows very swiftly over huge boulders and through narrow gorges, and it is therefore impossible, particularly at high stages, to use boats or to traverse the canyon longitudinally in any way. In order, therefore, to obtain the topography of this section it was necessary to descend into the canyon over cliffs and through narrow fissures in four different places. The topography of the talus slope for about 600 feet on the south side of the river was taken first by descending through a narrow fissure which, being of softer material than the granite cliffs of which the walls are generally

composed, had in the process of time eroded and made it possible for a party to descend. The party then, by means of a detour of approximately 150 miles, came down a similar fissure on the opposite side of the river and obtained the topography of that side for about an equal distance. About 12,000 feet further upstream they were able to descend again to another short talus slope, although the descent was extremely perilous, it being necessary for the party at times to descend over steep cliffs for several hundred feet by means of ropes. On the opposite side was another small talus slope, which was reached by a similar descent after the return of the party to the south side. There was one other small talus slope, between the extreme tracts already mentioned, which it was impossible for the party to reach with instruments, but one man descended this slope also by means of ropes, in order that he might set signals for triangulation. This dangerous piece of work was at last concluded, however, to the satisfaction of the chief of the party. The Uncompahgre Valley project is under the general direction of Mr. A. L. Fellows, district engineer; the men who made the descents into the canyon were Mr. I. W. McConnell, resident engineer, Mr. W. P. Edwards, assistant engineer, and Messrs. R. H. Sargent and L. E. Foster, topographers.

THE annual Blue-book relating to the British Museum has been published. According to an abstract in the London *Times* the report on the British Museum (Natural History) by Professor Ray Lankester, director, states that the number of visits was 433,619, compared with 417,691 in 1901. The attendance on Sunday afternoons has increased from 57,797 to 61,035. The average daily attendance was 1,197, for week-days only 1,201, and for Sunday afternoons 1,173. The report also states that the survey of the fishes of the Nile, begun in February, 1899, in cooperation with the Egyptian government, came to an end in June last. The work done since the last report was on the Blue Nile and White Nile. The former was explored as far as Rosaires, the latter as far as Gondokoro, where a valuable collection was made. The whole collection made during the three years' operations, amounting to some 9,500 specimens of over 100 species of fishes (14 being new to science), has reached the museum, and the final description of the material obtained is being proceeded with for publication by the Egyptian government. In consequence of the marked success which attended Dr. C. W. Andrews's mission to Egypt in 1901, he was again sent to that country last year, with treasury sanction, for the purpose of continuing the geological explorations in the Fayûm. The season's operations resulted in the acquisition for the museum, partly by excavations and partly by arrangements with the Geological Survey of Egypt, of a very important and valuable series of fossils, including remains of *Arsinoitherium, Palæomastodon,* etc. The collections thus acquired represent nearly all the important forms yet discovered in the locality, besides several species that are almost certainly new to science. The trustees have accepted a generous offer by Mr. W. E. De Winton to defray the expenses of carrying on geological explorations in Egypt for one or two seasons, and to present all the specimens obtained to the museum. Dr. Andrews has accordingly been despatched to Egypt to superintend the excavations in the present season. Mr. W. R. Ogilvie Grant, an assistant in the Zoological Department, has been authorized to proceed to the Azores to make a zoological exploration of that group of islands, with a view to collect specimens, the cost of the expedition being defrayed by Mr. Walter Rothschild, M.P. An arrangement has been made with the committee of the National Antarctic Expedition, under which the British Museum will receive the collections obtained, the trustees having agreed to publish the natural history results of the voyage.

The Experiment Station Record states that the successful work of the local agricultural experiment stations in Japan has made it possible for the ministry of agriculture and commerce to reduce the number of branch experiment stations connected with the Central Agricultural Experiment Station at Nishigahara, and to concentrate its efforts and

funds on a smaller number of stations and fewer lines of work. Until April, 1903, there were nine of these branch stations, but at that time six of them, viz., the Hokuriku, Too, Tokai, Shikoku, Sanio and Sanin branch stations, were turned over to the control of the local government, and the funds and staffs of these institutions were transferred to the Central Agricultural Experiment Station, and the three remaining branch stations, *i. e.*, those at Kashiwabara, Idzumimura and Hanadatemura. The funds available for the Central Station and its three branches for the fiscal year ending March 31, 1904, amount to $91,920. The total budget of the ministry of agriculture and commerce for the year is $3,386,713. The local stations referred to above now number thirty-nine. They receive subsidies from the ministry of agriculture and commerce amounting to $65,000 a year and also funds appropriated by the local governments. The annual expenditures of these stations vary from $2,200 to $11,232. In addition to the stations supported by public funds, there are three private experiment stations. The island of Formosa supports three agricultural experiment stations and a tea experiment station, all of which are under the control of the Bureau of Industries of Formosa.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. Joseph Pulitzer, the proprietor of the New York *World,* has given $1,000,000 to Columbia University to establish a school of journalism, and will add a second million when the school is in successful operation at the end of three years. President Butler announces that the school will take rank with the existing professional schools of law, medicine, engineering, architecture and education, and that a building will be erected at once at a cost of about $500,000.

The Experiment Station Record states that the total appropriation for the Pennsylvania State College made by the state legislature at its recent session was $250,805.55. Of this amount $100,000 is for the purpose of assisting in the erection, equipment and furnishing of a building for the department of agriculture of the college, while $150,000 additional is virtually pledged by the attachment of a proviso requiring the trustees of the college to file with the auditor-general plans, specifications and estimates satisfactory to him showing that the entire cost of the building and equipment will not exceed $250,000.

By the will of Mary P. Eakin, of New London, Yale University receives one third of her estate, about $5,000. It is given without restrictions as a memorial to her late son, W. S. Eakin, of the class of 1892.

Dr. Waldemar Koch, Ph.D. (Harvard, 1900), has been elected assistant professor of physiological chemistry and pharmacology in the University of Missouri. Dr. Koch is spending the summer at Strasburg and will spend the autumn months in England. He assumes his duties in the University of Missouri on January 1.

Dr. J. R. Murlin has resigned from Ursinus College to become instructor in physiology at University and Bellevue Hospital Medical College.

Professor Charles K. Francis, who has been junior professor of chemistry in the Georgia School of Technology for some time, has resigned to accept the chair of chemistry in Converse College, Spartanburg, S. C.

Mr. Howard Marsh, surgeon to St. Bartholomew's Hospital, London, and formerly professor of pathology and surgery at the Royal College of Surgeons of England, has been elected to the professorship of surgery at Cambridge University, which has been vacant since the death of Sir G. M. Humphry, F.R.S.

M. Andoyer has been appointed professor of physical astronomy and M. Painlevé professor of mathematics at the University of Paris.

M. Padé has been made professor of mechanics at Bordeaux and M. Lebœuf, professor of astronomy at Besancon.

Dr. Arthur Korn has been elected associate professor of theoretical physics and Dr. von Weber associate professor of mathematics at the University of Munich.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 28, 1903.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES.

THE degree of doctor of philosophy has this year been conferred on 266 candidates by 27 institutions. This exceeds by 10 the number conferred in 1901, and is doubtless the largest number ever conferred by American universities. The increase from year to year is, however, uncertain and small, the numbers for the six years being 234, 222, 239, 253, 216 and 266. It seems that the number of graduate students has increased more rapidly than the doctorates, which may possibly be due to somewhat more strict requirements. Still it is rather disappointing that the number of men with a proper training for research and advanced teaching increases so slowly. It should also be remembered that the number studying in Germany tends to decrease.

The statistics here given do not agree with those published subsequently by the U. S. Commissioner of Education, and as the latter figures are widely quoted, it may be well to call attention to the fact that they are valueless. The report of the commissioner records 343 doctorates conferred in 1901, but the table shows that the largest number of degrees conferred on examination was by Taylor University at Upland, Ind., which gave the doctorate of philosophy to no less than 45 candidates. One may well wish to learn something in

regard to a university with such a remarkable record, and the information is given a few pages farther on in the report Taylor 'University' has no productive funds; its income from tuition and other fees was $4,000 and from other sources $500! Unless they are to do more harm than good, the commissioner of education must in this and other cases put his figures in a form that is not misleading.

The following table gives details in regard to the conferring of the degree during the past six years:

DOCTORATES CONFERRED.

	1898.	1899.	1900.	1901.	1902.	1903.	Total
Yale	34	30	26	39	29	36	194
Chicago	36	24	37	36	27	32	192
Harvard	26	24	36	29	31	28	174
Johns Hopkins	33	38	33	30	17	23	174
Columbia	22	33	21	25	32	39	172
Pennsylvania	24	20	15	25	14	29	127
Cornell	19	7	19	21	23	20	109
Michigan	7	4	5	3	10	10	39
Clark	12	5	9	7	1	4	38
New York	5	9	7	6	4	4	35
Wisconsin	5	7	5	5	6	2	30
Virginia	0	2	2	8	6	3	21
Brown	1	3	3	2	2	5	16
Columbian	1	0	5	3	2	4	15
Minnesota	1	2	3	2	3	3	14
California	1	3	2	2	1	3	12
Bryn Mawr	3	3	1	2	2	0	11
Princeton	0	3	3	3	1	1	11
Stanford	2	0	2	2	2	1	9
Nebraska	2	1	1	1	0	0	5
Boston	0	0	0	0	0	4	4
Vanderbilt	0	0	3	1	0	—	4
Washington	0	2	0	1	0	1	4
Georgetown	0	0	0	0	0	3	3
Kansas	0	1	0	0	0	2	3
Lafayette	0	0	0	0	0	3	3
North Carolina	0	0	0	0	2	1	3
Iowa	0	0	0	0	0	2	2
Lehigh	0	0	0	0	0	2	2
Syracuse	0	1	0	0	1	0	2
Cincinnati	0	0	0	0	0	1	1
Colorado	0	1	0	0	0	0	1
Tulane	0	0	1	0	0	0	1
Missouri	0	1	0	0	0	0	1
	234	224	239	253	216	266	1432

It will be noticed that five universities are distinctly in advance, and that a large majority of the degrees—four fifths—are conferred by seven universities. There has been no considerable change in the position of the universities during the years covered by the records, though there is apparently an increase at Columbia and Michigan and a decrease at Johns Hopkins and Clark.

The degree of doctor of science was conferred this year once by Harvard and once by Michigan, and is included with doctorates of philosophy. This degree is not needed as a substitute for the Ph.D. It does not mean that the student has done a different kind of university or even college work, but that he perhaps did not study Latin at school.* Harvard established an M.S. degree four or five years since and then abandoned it. Doubtless the D.Sc. will not survive long.

DOCTORATES CONFERRED IN THE SCIENCES.

	1898.	1899.	1900.	1901.	1902.	1903.	Total
Chicago	12	13	19	16	15	21	96
Johns Hopkins	19	17	20	19	9	10	94
Columbia	10	23	12	13	14	18	90
Harvard	11	7	15	15	14	15	77
Yale	11	15	10	18	10	13	77
Cornell	11	2	11	13	16	13	66
Pennsylvania	8	8	6	12	5	14	53
Clark	12	5	9	7	1	4	38
Wisconsin	2	4	1	3	4	0	14
Michigan	0	3	1	0	5	4	13
California	1	3	1	2	1	3	11
Columbian	1	0	3	1	1	4	10
Virginia	0	2	0	4	1	2	9
Brown	1	0	0	1	2	4	8
Bryn Mawr	1	2	1	2	1	0	7
Stanford	2	0	0	1	2	1	6
Minnesota	0	1	1	0	2	1	5
Nebraska	2	1	1	1	0	0	5
Princeton	0	3	1	0	0	1	5
Washington	0	2	0	1	0	1	4
Kansas	0	1	0	0	0	2	3
New York	1	1	0	1	0	0	3
North Carolina	0	0	0	0	2	1	3
Lehigh	0	0	0	0	0	2	2
Vanderbilt	0	0	1	1	0		2
Colorado	0	1	0	0	0	0	1
Iowa	0	0	0	0	0	1	1
Lafayette	0	0	0	0	0	1	1
Missouri	0	1	0	0	0	0	1
Syracuse	0	0	0	0	1	0	1
	105	115	113	131	106	136	706

In the second table the degrees awarded in the natural and exact sciences are given

* It may be suggested to 'Carolum Guilielmum Eliot · præsidem magnificum' that there is a slight lack of courtesy in calling attention to the fact that a man probably does not know Latin, and then printing his name 'Georgius' on the commencement program.

separately. It will be noticed that the numbers are nearly equally divided between what, for lack of better terms, we must call the sciences and the humanities. The order of the universities is not the same here as for the total number of degrees conferred, showing that the sciences are relatively more favored at some institutions than at others.

DOCTORATES CONFERRED IN THE SCIENCES.

	1898.	1899.	1900.	1901.	1902.	1903.	Total.
Chemistry	27	32	26	28	26	33	172
Physics	11	7	15	23	12	14	82
Psychology	18	15	9	13	8	16	79
Zoology	12	11	11	15	16	12	77
Mathematics	11	13	11	18	8	7	68
Botany	11	11	12	8	11	9	62
Geology	6	5	5	10	6	10	42
Physiology	4	1	4	1	8	8	26
Astronomy	3	2	4	5	2	4	20
Education	0	5	8	2	1	2	18
Sociology	0	5	3	3	4	2	17
Paleontology	0	4	2	1	0	2	9
Bacteriology	0	1	1	1	1	3	7
Anthropology	2	0	2	1	0	1	6
Anatomy	0	0	0	1	0	4	5
Agriculture	0	0	0	0	2	2	4
Engineering	0	0	0	1	0	3	4
Mineralogy	0	2	0	0	1	1	4
Pathology	0	0	0	0	0	3	3
Meteorology	0	1	0	0	0	0	1
	105	115	113	131	106	136	706

In the third table details are given for the separate sciences. More degrees are always conferred in chemistry than in any other science. This year there were 33 degrees in chemistry, 16 in psychology, 14 in physics, 12 in zoology and 10 in geology. We are pleased to note an increase in the number of degrees in pathology, bacteriology, physiology and anatomy. The universities conferring three or more degrees in a science are: Columbia—chemistry 4, geology 4, psychology 4, zoology 3; Pennsylvania—chemistry 5, physics 3; Chicago—chemistry 4, botany 4; Harvard—chemistry 4, psychology 4; Johns Hopkins—physics 4, chemistry 3; Clark—psychology 3; Yale—chemistry 3.

The names of those on whom the degrees were conferred and the subjects of their theses are as follows:

UNIVERSITY OF CHICAGO.

Solomon Farley Acree: 'Condensations in the Aromatic Series.'

Theodore Christian Frye: 'Fertilization and Attendant Phenomena in *Asclepias* and *Acerates*.'

Eugene Paul Schoch: 'The Red and the Yellow Mercuric Oxides and the Mercuric Oxychlorides.'

Edward Emery Slosson: 'On Acylhalogenamine Derivatives and the Beckmann Rearrangement.'

Charles Hugh Neilson: 'The Hydrolysis and Synthesis of Fats by Platinum Black.'

Ralph Waldo Webster: 'On Osmotic and Ionic Effects in the Absorption of Liquids by Animal Tissues.'

William Albert Hamilton: 'On the Convergency of the Series in the Determination of the Elements of Parabolic Orbits and the Errors Introduced in the Elements by Imperfections of the Observations.'

Mary Hefferan: 'A Comparative Study of a Group of Chromogenic Bacteria.'

Charles Ingbert: 'The Enumeration of the Modulated Nerve-Fibers in the Dorsal Spinal Nerve-Roots of Man.'

William J. Moenkhaus: 'The Development of the Hybrids Between *Fundulus heteroclitus* and *Menithia notata* with Especial Reference to the Behavior of the Maternal and Paternal Chromatin.'

Henry Taber Upson: 'Molecular Rearrangements in the Orthoamino Phenol Derivatives.'

John Broadus Watson: 'The Psychic Development of the White Rat Correlated With the Growth of its Nervous System.'

Harry Gideon Wells: 'Experimental Fat Necrosis.'

William Clinton Alden: 'The Evolution of the Darien Lobe of the Lake Michigan Glacier.'

Bennett Mills Allen: 'The Development of the Ovary and the Testis in the Mammals.'

Wallace Walter Atwood: 'The Glaciation of the Wasatch Mountains.'

John Frederick Garber: 'The Life History of *Ricciocarpus natans*.'

Kate Gordon: 'On the Psychology of Meaning.'

George Mellinger Holferty: 'Contribution to the Life History of *Potamogeton*.'

Oswald Veblen: 'A System of Axioms for Geometry.'

Harry Nichols Whitford: 'The Ecological Relations of the Coniferous Forests of the Flathead Valley, Montana.'

COLUMBIA UNIVERSITY.

Joseph Hershey Bair: 'The Practice-curve; a Study in the Formation of Habits.'

Rudolph Michael Binder: 'Feeling as the Principle of Individuation and Socialization.'

Myrick Nathaniel Bolles: 'The Concentration of Gold and Silver in Iron Bottoms reduced from Highly Ferruginous Copper Mattes.'

William Campbell: 'The Microscopical Examination of the Alloys of Copper and Tin.'

Charles William Dickson: 'The Ore Deposits of Sudbury, Ontario.'

George Irving Finlay: 'The Nephetite-syenite and Associated Dikes in the San Carlos Mountains, Tamaulipas, Mexico.'

Philip Bovier Hawk: 'Influence of Hemorrhage upon Metabolism.'

Ernest Norton Henderson: 'A Study of Memory for Connected Trains of Thought.'

Douglas Wilson Johnson: 'The Geology of the Cerrillos Hills, New Mexico.'

Ernest Beckwith Kent: 'Constructive Work in Elementary Education.'

Joseph Edward Kirkwood: 'The Comparative Embryology of the Cucurbitaceæ.'

Richard Swann Lull: 'Footprints of the Jura-Trias of North America, with a Preliminary Revision of the Eastern, Vertebrate Fauna of the Period.'

James Franklin Messenger: 'The Perception of Number.'

James Burt Miner: 'Rhythms: Motor, Visual, and Applied.'

Ida Helen Ogilvie: 'The Geology of the Paradox Lake Quadrangle, New York.'

George Braxton Pegram: 'Secondary Radioactivity in the Electrolysis of Thorium Solutions.'

Herman Simon Riederer: 'The Quantitative Determination of Bismuth as Molybdate.'

Louis Franklin Snow: 'The College Curriculum in the United States.'

Harry Beal Torrey: 'On Regeneration on Hydroids.'

Stephen Francis Weston: 'Justice in Taxation.'

HARVARD UNIVERSITY.

Frederick Bonnet: I., 'The Changing Hydrolytic Equilibrium of Chromic Sulphate'; II., 'The Compressibility of Metals.'

Charles Theodore Burnett: 'Influences on the Judgment of Number.'

David Raymond Curtiss: 'Binary Families in a Triply Connected Region, with Especial Reference to Hypergeometric Families.'

Knight Dunlap: 'Tactual Time: An Experimental Investigation.'

William Curtis Farabee: 'Hereditary and Sexual Influences in Meristic Variation: A Study of Digital Malformations in Man.'

Lawrence La Forge: 'The Geology of Somerville, Massachusetts.'

Thomas Calvin McKay: 'On the Relation of the Hall Effect to the Current Density in Gold.'

Kenneth Lamartine Mark: 'The Expansion of Gases by Heat under Constant Pressure.'

Amos William Peters: 'Metabolism and the Reaction of Division in Protozoa.'

Horatius Chamberlain Porter: 'Derivatives of Tetrabromorthobenzoquinone.'

David Camp Rogers: 'Coordinations in Space Perceptions.'

Marlow Alexander Shaw: 'Illusions of a Kinesthetic Character.'

Wilfred Newsome Stull: I., 'Association of Energy with Matter'; II., 'The Speed and Nature of the Reaction of Bromine on Oxalic Acid.'

Thomas Wayland Vaughan: 'The Eocene and Lower Oligocene Coral Faunas of the United States, with Descriptions of a Few Doubtfully Cretaceous Species.'

George Byron Gordon: 'The Serpent Motive in the Ancient Art of Mexico and Central America.'

UNIVERSITY OF PENNSYLVANIA.

Christian Carl Carstens: 'Endowments: A Study of Certain American Bequests.'

Dana Brackenridge Casteel: 'The Cell-Lineage and Early Larval Development of *Fiona marina*, a Nudibranch Mollusc.'

Homer Munro Derr: 'A Method of Petrographic Analysis Based upon Chromatic Interference with Thin Sections in Parallel Polarized Light.'

William Hastings Easton: 'The Reduction of Nitric Acid in Metallic Nitrates to Ammonia by the Electric Current.'

Franz Frederick Exner: 'The Rapid Precipitation of Metals, by the Rotation of the Anode, in the Electrolytic Way.'

Leon Wilson Hartman: 'A Spectrophotometric Study of the Luminous Radiation from the Nernst Lamp Glower under Varying Current Density.'

Burt Laws Hartwell: 'The Action of Organic Bases upon the Rare Earths.'

Carl Kelsey: 'The Negro Farmer.'

William McClellan: 'Thermo-Electric Behavior of Nickel Nitrate.'

Lewis Irving Neikirk: 'Groups of Order p^m which contain Cyclic Subgroups of Order p^{m-3}.'

James Allen Nelson: 'The Early Development of *Dinophilus;* a Study in Cell Lineage.'

Orville Paul Phillips: 'A Comparative Study of the Cytology and Movements of the Cyanophyceæ.'

George Philipp Scholl: 'The Electrolytic Determination of Manganese and its Separation from Iron and Zinc.'

Walter Thomas Taggart: 'Electrolytic Determination of Nickel and Phosphate Solution.'

CORNELL UNIVERSITY.

James Adrian Bizzell: 'Behavior of Phosphoric Acid in the Soil.'

Arthur Wesley Browne: 'Contribution to the Chemistry of Hydronitric Acid and the Trinitrides.'

William Weber Coblentz: 'Some Optical Properties of Iodine.'

Elmer Reginald Drew: 'The Radiant Efficiency of the Electric Discharge through Gases at Low Pressures.'

Jacob Goodale Lipman: 'Nitrogen-fixing Bacteria.'

Sanford Alexander Moss: 'The Gas Turbine.'

Perley Gilman Nutting: 'Ultra-violet Rotary Dispersion.'

Hugh Daniel Reed: 'The Cranial Osteology and Relationships of the Family Percopsidæ.'

William Albert Riley: 'The Embryological Development of the Skeleton of the Head of *Blatta*.'

Emil Peter Sandsten: 'Conditions which Affect the Fertility of Pollen.'

Ernest William Schoder: 'An Experimental Study of the Resistances to the Flow of Water in Pipes.'

John Edgar Teeple: 'On Bilirubin, the Red Coloring-matter of the Bile.'

George Washington Tapley Whitney: 'Recent Theories of Psychical Causality.'

YALE UNIVERSITY.

John Charles Blake: 'On Colloidal Silver and Gold.'

Wilton Everett Britton: 'Vegetation of the North Haven Sand Plains.'

Edgar Roscoe Cumings: 'The Morphogenesis of *Platystrophia;* A Study of the Evolution of a Paleozoic Brachiopod.'

William Ebenezer Ford, Jr.: 'Investigations in Mineralogy.'

Henry Franklin Merriam: 'Researches in Organic and Inorganic Chemistry.'

Helen Abbot Merrill: 'On Solutions of Differential Equations which Possess an Oscillation Theorem.'

Oscar Stoddard Pulman, Jr.: 'The Quantitative Determination of Uranium, with Applications to the Estimation of Phosphoric Acid; to which is Appended a Method for the Determination of Molybdic Acid, with Application to the Estimation of Phosphoric Acid.'

Allen Douglas Risteen: 'The Numerical Evaluation of the Absolute Thermodynamic Scale of Temperature.'

Henry Hollister Robinson: 'Geology of San Francisco Mountain and Vicinity, Arizona.'

Elias Howard Sellards: 'A Study of Some Paleozoic Plants and Insects.'

Carl Ebin Stromquist: 'On a Special Case of the Generalized Integral of Length, together with Certain Contributions to the General Theory.'

Frank Pell Underhill: 'Further Experiments on the Physiological Action of the Proteoses.'

George Benjamin White: 'Purin Metabolism and Allantoin Formation, an Experimental Study.'

JOHNS HOPKINS UNIVERSITY.

Benjamin Franklin Carver: 'A Study of New Semi-permeable Membranes Prepared by the Electrolytic Method.'

Henry Augustus Converse: 'On a System of Hypocycloids of Class Three Inscribed to a given 3-line and some Curves Connected with it.'

John P. Coony: 'A Study of Some New Semi-permeable Membranes.'

Charles Keyser Edmunds: 'Some Optical Properties of Selenium: A. Metallic Reflection Phenomena; B. Reflecting Power.'

John Gale Hun: 'The Invariant Relations of Two Triangles.'

Albert Johannsen: 'The Serpentines of Harford County, Maryland.'

George Wiles Middlekauff: 'Measurements of Certain Wave-lengths in the Spark-spectra of Iron and Titanium, Together with a Study of the Possible Influence of Capacity and Self-Induction in the Spark Circuit.'

Joseph Haines Moore: 'The Absorption and Fluorescent Spectra of Sodium Vapor.'

Atherton Seidell: 'The Precipitation of Zinc by Manganese Peroxide, with Especial Reference to the Volhard Method of Determining Manganese.'

Arthur Whitmore Smith: 'A Determination of the Heat of Fusion of Ice.'

BROWN UNIVERSITY.

Caleb Allen Fuller: 'The Distribution of Sewage in the Waters of Narragansett Bay and its Relation to the Oyster Beds.'

George Freeman Parmenter: 'The Action of Acetic Anhydride on Acids of the Phenylpropiolic Series.'

Michael Xavier Sullivan: 'Synthetic Culture Media and the Biochemistry of Bacterial Pigments.'

Ralph Winifred Tower: 'The Comparative Anatomy and Physiology of the Swim-bladder of Fishes.'

CLARK UNIVERSITY.

Roy T. Wells: 'On the Induction of Currents in Cylindrical Cores.'

Lonna Dennis Arnett: 'Ideas of the Soul.'

Fred Kuhlmann: 'Experimental Studies in Mental Deficiency: Three Cases of Imbecility (Mongolian) and Six Cases of Feeble-mindedness.'

Edgar James Swift: 'Studies in the Psychology and Physiology of Learning.'

COLUMBIAN UNIVERSITY.

Edwin Allston Hill: 'The Constitution of Oxyacids from the Thermochemical Standpoint.'

William Mather Lamson: 'On Iron and Steel Domes.'

Thomas Malcolm Price: 'The Influence of Varying Strength Solutions of Formaldehyde on Some of the Enzymes of Animal Origin.'

Harriet Richardson: 'Contributions to the Natural History of the Isopoda.'

UNIVERSITY OF MICHIGAN.

Louis Merwin Gelston: 'The Intracellular Toxins of the Diphtheria and Typhoid Bacilli.'

Mary Frances Leach: 'A Contribution to the Study of the Chemistry of the Bacillus Coli Communis.'

Mary Wheeler: 'The Chemistry of Bacterial Cells, with Special Reference to the Yellow Sarcine and the Typhoid Bacillus.'

Charles Willis Johnson: 'On the Action of Oxidizing Agents upon Morphine.'

UNIVERSITY OF CALIFORNIA.

Arthur Scott King: 'The Structure of Arc Spectra, and Some Effects of Change in Physical Conditions.'

Harold King Palmer: 'An Application of the Crossley Reflector of the Lick Observatory to the Study of very Faint Spectra.'

Joel Stebbins: 'The Spectrum of o Ceti.'

UNIVERSITY OF KANSAS.

Hamilton Perkins Cady: Chemistry.

Clarence Erwin McClung: Zoology.

LEHIGH UNIVERSITY.

Joseph W. Richards: 'A Calorimetric Study of Copper.'

Herman E. Keifer: 'A Study of Some Derivative of Meta-Diazo-Benzene-Sulphonic Acid, and the Action of certain Alcohols on Asym-Meta-Diazo-Xylene-Sulphonic Acid.'

UNIVERSITY OF VIRGINIA.

James Park McCallie: 'A Problem in Periodic Orbits, Second Order Perturbations of Jupiter and Saturn, Independent of the Eccentricities and of the Inclinations.'

J. P. Montgomery: 'On some New Compounds of Urea with Acids and Salts.'

STATE UNIVERSITY OF IOWA.

Mabel Clare Williams: 'Normal Illusions in Representative Geometrical Forms.'

LELAND STANFORD JUNIOR UNIVERSITY.

Anton Julius Carlson: 'Contributions to the Physiology of the Central Nervous System of the Snake.'

LAFAYETTE COLLEGE.

George W. Twitmyer: 'The Diagnosis and Treatment of Backward, Dull and Defective School Children.'

UNIVERSITY OF MINNESOTA.

Harold L. Lyon: 'On the Embryogeny of *Ginkgo biloba*.'

UNIVERSITY OF NORTH CAROLINA.

Royall Oscar Eugene Davis: 'The Atomic Weight of Thorium.'

PRINCETON UNIVERSITY.

Archer Everett Young: 'Isothermal Asymtotic Curves.'

WASHINGTON UNIVERSITY.

James Arthur Harris: 'The Dehiscence of Anthers by Apical Pores.'

THE SUMMER LABORATORY AS AN INSTRUMENT OF BIOLOGICAL RESEARCH.*

There are three kinds of summer biological stations:

I. Laboratories devoted to instruction alone. Of such a laboratory it may be said that it has no real reason for its existence. Its work can be done better, as a rule, in the existing college and university laboratories.

II. In the second place, there are some summer laboratories which are devoted to research exclusively.

III. The third class will include those combining research with instruction. Here belong our best and most flourishing institutions. The combination is good for both sides, and it is absolutely necessary to the instruction if it is to be maintained at a high standard of efficiency. The instruction may be, and in general should be, different in method and usually in subject matter from that given in the schools. In biology it is generally the natural history or ecological side which receives special emphasis, and rightly so, since these are subjects which can hardly be pursued under other conditions than those by which we are here surrounded.

I shall speak to-day chiefly of the research function of the laboratory. I do so the more cheerfully knowing the excellent record which this station has behind it in the matter of research, and having all confidence that it has a much wider future from this day onward.

The necessary conditions for research in biology fall into two great groups:

1. Material conditions—suitable buildings, apparatus, etc., a rich and diversified fauna and flora conveniently near and an environment sufficiently varied to promote ecological and experimental researches in biology. All of these conditions are obviously abundantly fulfilled in this laboratory; but I shall not attempt to enlarge upon them, as that would be to trespass on a theme better treated by our director himself.

2. There are, in the second place, certain conditions of successful research which we may term provisionally the subjective conditions. These are really of far greater importance than the material conditions, but more difficult to control. I propose that we consider some aspects of these conditions for a few minutes in the hope of gaining thereby a better insight to the real purposes of a lake-side laboratory of natural history and thus securing greater efficiency in our work here.

It is the investigator's own self—his bodily and mental organization—which is the most important instrument of research with which we have to do. Our problem, then, is nothing other than how best to bring this apparatus up to the highest state of efficiency. This laboratory, whose guests we are to-day, is clearly provided with all the material facilities for a great research center. It will make the most of these opportunities and enlarge these facilities, without doubt. Its staff is composed of tested and approved research workers. Their efficiency too is doubtless capable of further development. I ask, then, what may we expect from the laboratory in this far more difficult, yet vitally important, field of activity—the culture of the investigator himself?

Before we attempt to formulate our aims, our ideals, of what a laboratory should do for its investigators, we may properly inquire into the fundamental nature of research in general.

A few weeks ago a young man whom we may call Linton (I hasten to explain that he is not a disciple of mine) came to

* Address delivered at the opening of the Lake Laboratory, Sandusky, O., July 2, 1903.

the door of my laboratory with a parcel under his arm and asked if he might have the use of my best compound microscope for a few minutes. I invited him in and he proceeded to unwrap a dead crow which he spread out on a table and with a sharp pocket knife dissected rapidly until he had exposed certain tendons running from the bases of the primary wing feathers to the joints of the wing and thence to the sternum. Then calling attention to these tendons, he asked for his microscope. I suggested that it is not customary to use the compound microscope for that class of work and inquired whether a dissector would not be better adapted to his purpose. To this he assented and forthwith asked for my best dissecting microscope. I supplied his wants and left him. Returning in the course of half an hour I found him still examining carefully the whole length of these tendons and their attachments. Looking up he asked if I knew of any force other than that of the atmosphere and the bird's muscular movement which keeps the bird suspended in the air. Upon my replying in the negative, he proceeded to elaborate an electric theory of flight, the sternum being conceived as the generator (he reports that he has occasionally received slight electric shocks from the breast bone of freshly killed birds), the tendons shown by his dissections being the conductors and the entire surface of the spread wing being thus highly charged with electricity. At this point I ventured to inquire how the electric charge acts to keep the bird afloat. This he did not know, but thought it ought to do so.

Now, here is a bright man, full of ideas and enthusiasm, willing to do much hard labor to work out his conceptions. Why are his researches abortive, their only value being to afford a hearty laugh and a few minutes of interesting diversion in the midst of his daily grind to a jaded college professor? Here is valuable energy—for the man is no fool, he is simply untrained—going to waste merely for lack of correlation. The man is unable to put his own ideas into relation with the great body of science, and hence he is still in blissful ignorance of the fact that he has succeeded only in making a laughing-stock of himself. The most elementary knowledge of electricity would of course have shown him the absurdity of his proposition. And when we investigators of mature experience publish scientific vagaries or fantastic theories (as we all do sooner or later if we do much really creative work), our failure is traceable in the end to the same defective correlation as is Linton's electric theory of flight. So soon as the facts are all in, such excrescences of scientific fancy are trimmed off automatically.

If now we attempt to interpret research in terms of the current dynamic conceptions of consciousness and of things in general, we may conveniently subdivide the history of any given special investigation somewhat as follows:

I. We have first the preliminary steps which we may characterize, to borrow a medical term, as the prodromic stages. These include the investigator's whole previous life, the sum-total of his experience so far as it has affected his mode of thought and his fund of ideas. His consciousness may be conceived as for the moment in a state of relatively stable equilibrium. This equilibrium, however, is not perfect. His fund of knowledge is not complete, nor even symmetrically incomplete, but it is full of gaps.

To some men these gaps are not significant. Their phenomenal world is completely filled (no matter how contracted their horizon), as one fills out automatically and unconsciously the blind spot on his

own retina. Such people never become investigators.

To some other people, on the other hand, every break in the continuity of our knowledge is a distressing thing; merely to state a problem is to call into being a center of unrest. Our investigator manifestly is of this type. He looks at the world as in a broken mirror, full of irregular gaps and distortions, every one of which is to him more or less painful. We can not therefore speak of the resting stage of his consciousness as in perfectly stable equilibrium.

II. In this condition he receives some impression—let us say, to take an illustration from my own recent experience, a peculiar movement of the catfish hitherto unobserved—which serves to direct attention to some one of these tender spots of consciousness, in other words, to some biological problem. The known facts bearing on that problem become focalized in the investigator's mind, and that which was before a consciousness in relatively stable equilibrium becomes a tensional system in very unstable equilibrium—it becomes, in fact, at-tention.

Our student has now selected his problem, let us say the function of certain cutaneous sense organs upon the barblets of the catfish, the stimulation of which he supposes may have occasioned the peculiar movement above referred to.

We are in the habit of saying that the 'research' now begins; as a matter of fact the research is already well under way. Well begun may be more than half done in this case. The meaning of the problem and the value of its solution will be determined by the character of the initial tensional system, and this in turn rests upon the investigator's wealth of mental content in what I have called the prodromic stage—in common parlance, upon his preparation for research. The observed fact in the beginning would have suggested no problem unless his previous fund of experience had permitted a prophetic insight into its meaning—'in-sight' as distinguished from 'at-sight,' or the meaningless gaze of the untutored mind, to use a happy antithesis of Dr. Paul Carus.*

III. Now, tension means dis-harmony. The solution of the problem involves the release of this particular tension in consciousness and the return to equilibrium, or the correlation of the new fact observed with the preexisting body of fact. The probability is that this can not be done directly; they do not fit together. The student now proceeds to accumulate new facts suggested by those already known, with the expectation of being able finally to complete the system, effect the correlation, and so relieve the tension. This is observation and experiment.

His fish, to return to our illustration, is placed under experimental conditions and its reactions noted under a great variety of modes of stimulation, the observer's mind being always alert for an observation which correlates with facts previously noted.

IV. This process involves the dissociation so far as possible of fact and meaning, of observation and interpretation, and this dissociation in consciousness of things which in nature actually belong together *is* the tension. The facts must be objectified, personal equation must be eliminated or allowed for, prejudice avoided, and when the series of facts as thus objectified is sufficiently complete so that fact hangs with fact and the whole forms a natural unit, then the interpretative series (which in the first place set the direction of the research) again becomes dominant, fact and interpretation fit to-

* In the 'Primer of Philosophy.' Cf. the 'intuition' *vs.* 'at-tuition' of Laurie.

gether, the tension is relieved, correlation is effected, the problem is solved.

The student finds, for example, that the observed reaction of the catfish under consideration is produced by the chemical stimulation of certain taste buds on the barblets; in other words, that the fish tastes with the barblets as well as with the tongue. The steps in the observational series are these: The movement made when the barblets touch food is to turn and snap up the morsel and swallow it. It is a sensori-motor reaction similar to those from the eye and nose. This is our first correlation. It is not a tactile reaction, because it does not occur after contact with a tasteless object such as gelatin. In the same way the participation of other sense organs may be experimentally eliminated until chemical stimulation (taste) is left as the only possibility. It is a fact of observation that there are sense organs on the barblets which resemble in structure the taste buds in the mouth; the two groups of sense organs are known to be supplied by similar nerves both of which are connected with the gustatory centers within the brain. Experiment now shows that the two sets of sense organs have a similar function, and the coordination of our factual series with the interpretative series is complete—the reaction is a gustatory reaction.

The working hypothesis in the research from this point of view is an anticipation of the 'meaning' of the factual series in advance of the discovery of all the facts. The value of the hypothesis is simply to point the direction for the accumulation of further facts. If a coherent series of facts can be found which coincides with the provisional explanatory series, the solution is found; if not, another provisional explanation must be produced.

In all these cases the test of fitness is the coordination of fact with fact, and fact with explanation. That done, the gap in our knowledge is filled, our world of knowledge becomes by so much larger, and the painful tension of disconnected experience gives place to the satisfaction of correlation and integration of the new with the old and consequent broadening out of the meanings of life, which is really creative work. In proportion as the newly acquired facts and interpretations can be broadly correlated with the existing fund of knowledge, in just so far is the research really great.

Now the ability to make this correlation at the end is the same kind of ability as that which is necessary at the beginning to get the good 'point of view' from which to choose a fruitful problem and shape efficient working hypotheses. No liberality of financial endowment, no profusion of material equipment, no wealth of faunal and floral environment, will compensate for its absence. Nothing can come out of the place which is not inherent within its men. Our first aim must, then, be to safeguard the investigator himself.

To return, then, to our theme, there are very practical ways in which the summer laboratory may contribute, as no other can, to the culture of the investigator himself, and it is this function which I conceive to be the most important justification for its existence.

Most of us who go from home to these biological stations leave well-equipped laboratories of our own, and not infrequently the particular research in hand can actually be done more conveniently at home than abroad. It has been my custom for years, at the beginning of the summer, to pack up my slides and other research materials and carry them at considerable expense of time and money to a seaside laboratory where two or three months are

spent, not in the study of marine types, but in the elaboration of my collections made in Ohio and for which my own laboratory furnishes the necessary equipment better than those to which I have made my annual migrations. Nevertheless, I have always felt that the time and money so spent were profitably invested—indeed the expenditure has actually been necessary to the highest efficiency of the research.

The apparent paradox is fully explained when it is remembered that the man can put into the research no more than he has in himself. The investigation is no external thing which he makes; *it is his life,* and the man must first be broadened, deepened and rounded out, if this manifestation of his inner life is to have real power, is to become an efficient factor in the world's work. This the summer laboratory can do, and can do with small material outlay, if only we go at the thing in the proper way.

Most of us are closely shut up during the nine months of the school year in the confined atmosphere of our own laboratories, often in almost total isolation from our confrères with whom we are (or should be) collaborating in the prosecution of our researches. In such a case one naturally slip into ruts, and sooner or later, unless the situation is relieved, his work will give evidence of a mildew, or perchance a dry rot will permeate his best work, so that freshness, originality and virility gradually give place to dreary routine or to grotesque fantasy.

That this is not the inevitable outcome of the sort of solitary confinement to which many investigators, particularly those in the smaller colleges, are of necessity condemned is clear from the history of many of our most illustrious research workers whose most valuable contributions have been produced under just these conditions. But the fact remains, that just in proportion as our work will prove of real and permanent value, we must keep ourselves in touch by some means or other with the outer world, with the current tendencies and advance movements of research in cognate lines. This can of course be done in great measure through the medium of the press, but nothing can take the place of real, vital contact with other investigators in the flesh. Here we get not only inspiration and stimulus in general, but often items of direct value to our own work years in advance of their publication.

The summer laboratory should be a clearing-house of scientific ideas, not merely a hotbed or forcing house for budding researches. To meet this need it is evident that the greater the diversity in personnel and range of interests represented the better. That which the university student prizes most is the intimate daily contact in the lecture room and laboratory with his instructors. In the properly organized summer biological station every worker comes into that same sort of relation with every other worker, and this, I take it, is the best that the station can offer to its patrons. To attain the highest efficiency there must, therefore, be sufficient flexibility of organization and diversity of interests represented to correct the tendencies toward intellectual in-breeding which we find in most of our university and college laboratories and to secure a sort of cross-fertilization of scientific organizations.

Regardless of the individual investigator's problem and method, he can well afford to utilize such opportunities; indeed he can not afford, except in unusual cases, to neglect them for long periods, if he would retain his intellectual tone and elasticity. The station, in short, is an

exceptionally favorable aid in effecting that breadth of view and perfection of coordination which we have seen to be the keystone in the arch of scientific achievement.

It is a source of congratulation to us, the members of this laboratory, that these liberal principles are clearly at the foundation of our present organization. Our director has made it very plain, not only by word of mouth, but much more forcibly in practical ways, that it is to be the policy of our laboratory to secure the widest cooperation among all the men of science of our state. To this, as the representative of organized science in Ohio, I have pleasure in responding with equal cordiality that it will be our purpose to share in the great work here established to the full extent of our ability, by attendance when possible, and by sympathetic interest at all times. While we are the gainers by this liberal hospitality offered by the laboratory, it is certain that the laboratory in thus casting its bread upon the waters will find it again after many days.

Permit me in closing to quote a paragraph from the article recently published in the special Christmas number of *Mind!* entitled, 'Specimens of the Critique of Pure Rot, from the remains of a Philosopher, by I. Cant.' "Let us begin by inquiring into the possibility of Rot in general. That Rot exists you may take my word. And there are two kinds of it: damp rot and dry rot, besides certain fungoid growths." To which of these categories this effort of mine belongs, I leave you to judge—whether it is damp rot or dry rot, or merely a relatively innocuous fungoid growth which will deliquesce with the rise of tomorrow's sun.

C. Judson Herrick.

Denison University.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.*

It may be well to briefly outline the history of the International Catalogue of Scientific Literature before recounting the condition of the work at present.

The original suggestion of an international catalogue came from Professor Joseph Henry, first secretary of the Smithsonian Institution, who in 1855 called the attention of the British Association for the Advancement of Science to the great need of a work of this kind. The idea was in advance of the times, and not until 1867 did it bear fruit in the publication by the Royal Society of the well known 'Catalogue of Scientific Papers.' In this publication Professor Henry was given due credit as the originator of the idea, but the work itself was only in part the realization of his plan, dealing as it did with serial publications only and indexing them by authors' names alone. However, with this start the plan lived and progressed until 1894, when the Royal Society, feeling that the time had come to improve the plan of their catalogue, and assured that this could be effected only by international cooperation, addressed a circular to the learned societies of the world, bringing the matter to their notice. By the advice of the societies responding to this circular the Royal Society through the British Foreign Office invited the governments of the world to send delegates to a conference to be held in London in 1896. At this and the two following conferences of 1898 and of 1900 the plan took shape and it was decided to start the work with a classified subject and author catalogue of all original scientific literature beginning with January 1, 1901. The following named sciences were to be included within the scope of the catalogue, one volume a year being devoted to each of

* Read before the Bibliographical Society of Chicago.

the following seventeen sciences: Mathematics, mechanics, physics, chemistry, astronomy, meteorology (including terrestrial magnetism), mineralogy (including petrology and crystallography), geology, geography (mathematical and physical), paleontology, general biology, botany, zoology, human anatomy, physical anthropology, physiology (including experimental psychology, pharmacology and experimental pathology) and bacteriology.

The organization was to consist of a central bureau in London to edit and publish classified references to the current world's literature furnished by regional bureaus established in and supported by the principal countries of the world. After much discussion a system of classification was adopted which divided each science into specific, numbered subdivisions under one or more of which it is possible to classify any paper on any subject within the domain of science. Conversely, when any subject is to be investigated the plan is first to find the subject-heading in the classification schedule and to use the number there given instead of a page number in looking up the grouped references in the body of the catalogue, the pages of which bear the schedule numbers in addition to page numbers. As, with the exception of additions, these subdivisions and numbers are the same from year to year, this method will materially aid in investigations covering a term of years.

Full histories of the conferences have been published by the Royal Society in three pamphlets entitled, respectively, Reports of the proceedings at the first, second and third international conferences on a catalogue of scientific literature. Brief accounts by the writer of this paper covering the history of the enterprise from its beginning through the second conference have been published in Science, August 6, 1897, and June 2, 9, 1899.

When the third conference had finally decided to begin the work, many of the delegates attending were empowered by their governments to promise official aid to the undertaking, but although Congress had been petitioned to aid in the matter, no action had been taken and the United States, therefore, was unrepresented.

Regional bureaus were established in the following countries: Austria, Belgium, Canada, Cape Colony, Denmark, Egypt, France, Great Britain and Ireland, Germany, Greece, Holland, Hungary, Italy, India and Ceylon, Japan, Mexico, New Zealand, New South Wales, Norway, Portugal, Poland, Queensland, Russia, South Australia, Sweden, Switzerland, Victoria, Western Australia and Finland. Authority over all questions of methods and administration is vested in an international convention to be held in London in 1905, 1910 and every tenth year following.

Failing in governmental appropriation, the Smithsonian Institution felt obliged to render its fostering aid to the project in the United States, otherwise the whole enterprise might have been abandoned. The Institution was at the time enabled to devote a sum of money to carry on the work here provisionally, which, together with gratuitous aid, rendered it possible to make a start. Up to the present time the very limited means at the disposal of the Institution has greatly hampered the work here. However, beginning with July 1, 1903, the force employed will be increased, as it has been possible for the Institution to devote a sum of money to this purpose which has heretofore been otherwise employed. This will not only enable the Institution to deal properly with the current publications in the United States, but will render it possible to make good the omissions occurring from January 1, 1901, to the present time.

Congress has been approached on several occasions in the endeavor to have the

United States officially take its place with the other great nations in this work, but though the Department of State has on four occasions strongly recommended to Congress the advisability of making a suitable appropriation for the work, to be expended under the direction of the secretary of the Smithsonian Institution, no appropriation has as yet been made and it is feared that, owing to the growing disposition on the part of some members to oppose all grants for purely scientific work, the hope of future aid from this source is not encouraging.

On account of the necessary delays attending the beginning of a work of this kind, only the index of part of the first year's literature has so far been published. To be more exact, nine complete and three part volumes of 1901 are now published, besides a list of journals.

It was at first hoped that valuable aid could be obtained from existing card indexes in the different scientific branches of the government, but experience has shown that, owing to the dissimilar methods used, it is practically as difficult to transpose, verify and properly classify the references obtained in this manner as it is to obtain the data at first hand. The Geological Survey, however, has aided greatly in the preparation of the volumes on mineralogy, geology and paleontology, and much valuable aid has been had from the Library of Congress and the Hydrographic Office, besides the bureaus immediately under the Smithsonian Institution. Especial recognition is due to Dr. Theodore Gill, whose ever-ready advice in all mooted questions relating to zoological taxonomy has rendered aid such as could only be had from an authority whose decisions are beyond question.

To give some idea of the extent of the work in this country I may say that approximately twenty thousand classified reference cards have been forwarded by the Smithsonian Institution to the London Central Bureau. Of these over thirteen thousand dealt with the literature of 1901.

The method here employed is briefly this: A numbered card record file is kept of the titles of the periodicals published in the United States which are likely to contain matter on scientific subjects; this record is systematically gone over at regular intervals and the periodicals called for from the Smithsonian Library which aims to receive all such publications. The contents of the publications themselves are indexed separately on cards, and each card duplicated as many times as necessary in order to send to the Central Bureau (besides the regular reference by authors' names) one card for each of the subjects into which the paper is classified. Duplicate author reference cards on which are noted the assigned classification are kept for file, and a record kept of the entire publication on the periodical cards already referred to. By this method it is possible not only to duplicate the work at any time but to check and make good any omissions.

Separate publications and books are treated in like manner in regard to classification, although the methods of obtaining notice of their appearance is necessarily different.

To classify properly into minute subdivisions, such as are employed in this work, the vast amount of scientific matter appearing in this country is a difficult task, but every effort is used to make the references exact, and where there is any intricate question involved the advice of a specialist is asked. I desire to acknowledge the valuable services of Mr. L. C. Gunnell and Miss Rose A. Palmer, who have brought intelligence, enthusiasm and industry to the work of indexing and classification. At the central bureau a corps of referees

are employed, a specialist for each science, who, to guard against error, review each reference before publication.

It is a matter of congratulation that this country leads in the number of subscribers to the catalogue, the number being 96, equivalent to over 70 complete sets. The individual volumes may be subscribed to for a sum *pro rata* to the cost of the full set. As the yearly subscription to the full set of seventeen volumes is $85, this is an encouraging showing. Although this catalogue has not been free from the defects and consequent criticism attending all new enterprises, the work itself is being done in a way to furnish a helping hand to both librarians and students who have long needed a concise subject index to the great and ever-increasing scientific literature of the day. This field the International Catalogue of Scientific Literature aims to cover.

Cyrus Adler.

Smithsonian Institution,
June 19, 1903.

SCIENTIFIC BOOKS.

NEW TEXT-BOOKS IN PHYSICS.

A Laboratory Manual of Physics. By Henry C. Cheston, Philip R. Dean and Charles E. Timmerman. New York, American Book Company. 1903. Pp. 128.

Laboratory Exercises in Physics. By George R. Twiss. New York, The Macmillan Company. 1902. Pp. 193.

A Manual of Elementary Practical Physics. By Julius Hortvet. Minneapolis, H. W. Wilson. 1902. Pp. 276.

Practical Physics for Students of Science and Engineering. By Ervin S. Ferry. LaFayette, Ind., Burt-Terry-Wilson Co. 1903. Part I. Pp. 146.

Mechanics, Molecular Physics and Heat. By Robert A. Millikan. Chicago, Scott, Foresman & Co. 1902. Pp. 242.

Elements of Physics. By Fernando Sanford. New York, Henry Holt & Co. 1902. Pp. 426.

Elements of Physics. By Ernest J. Andrews and H. N. Howland. New York, The Macmillan Company. 1903. Pp. 386.

Introduction to Physical Science. By Alfred Payson Gage. Boston, Ginn & Co. 1902. Pp. 359.

Text-Book of Physics. By R. A. Lehfeldt. London, Edward Arnold. 1902. Pp. 304.

Light, for Students. By Edwin Edser. London, Macmillan & Co. 1902. Pp. 571.

Lehrbuch der Physik; Erster Band, Mechanik. Von O. D. Chwolson, St. Petersburg; übersetzt von H. Pflaum. Braunschweig, Friedrich Vieweg und Sohn. 1902. Pp. 791.

The annual crop of new text-books of physics is becoming so large that the bewildered reviewer is scarcely able any longer to discuss them distributively; or, if so, it has to be by some system of grouping with comparison of the members of each group. A threefold division may perhaps be made according to the apparent aims of the authors. The first group consists of those which are intended for use chiefly or entirely in the laboratory. The second is made up of those adapted for class-room use in connection with oral exposition. The third includes books intended neither for the laboratory nor for the class-room primarily, but as systematic presentations of principle, to be mastered by private reading in courses of parallel study accompanying the formal lectures or in preparation for formal examinations.

To the first group distinctly belong the first four books of the present list. In the preparation of an elementary laboratory manual there is no longer much range for great originality or for adaptation to a large clientage. The first volume is a little book of 128 pages, prepared by three authors, who frankly begin by saying: "The reason for adding this book to the large number of laboratory manuals is that those now in use either contain too much matter to be successfully covered by a pupil in one year, or elaborate the principles chosen without regard to economy in time." The authors of the other manuals may perhaps differ with these authors as to what constitutes too much matter and in regard

to economy of time. Everything depends upon the special circumstances to which each author has to adapt himself. Any laboratory teacher will probably be able to extract something useful from any laboratory manual if he is alert. Instructions must be well methodized and put into good form, but in no case can they be a complete substitute for the instructions needed in any laboratory other than that in which the given manual was developed. The volumes by Mr. Twiss and Mr. Hortvet are, like the first, good examples of method, all of them being intended for secondary schools, but containing material that can be utilized by beginners in college. Their purpose is, as well expressed by Mr. Hortvet, 'to teach pupils to measure accurately, to manipulate carefully, to work methodically, to see fully, to reason intelligently and to express their observations and results clearly.' It would be an untold blessing to all students of science, irrespective of age or specialty, if such ideals were unceasingly kept in view and even approximately attained.

The small volume by Professor Ferry is the first of a series consisting of four parts, the second of which is now in press. They are intended for students who have a distinct object in view, that of preparation for the profession of engineering. They are, like all such books, the outcome of local needs, where a large number of students require simultaneous attention. The aim is 'to furnish the student with a laboratory manual of physical processes and measurements in which the explanation of the theory and the description of the method of manipulation of each experiment is so complete as to preclude the necessity of consulting either another book or a laboratory instructor.' Doubtless there are many besides the reviewer who have been doing just this task for years past. Hundreds of pages of manuscript have been prepared, some of which are discarded every year, while the need of new instructions adapted to changing conditions is periodically presenting itself. Many of the details of routine may be confided to assistants, but the calls upon the laboratory director will cease only when he gives up his post. Nevertheless the method is on the whole economical. It saves much repetition; it enables the slow student to study out difficulties with a minimum of personal aid; it tends to make him appreciate the advantage of depending on himself to supplement by thought whatever shortcomings may seem to exist on pages prepared for the average student rather than for any single individual. Professor Ferry has done his work with much skill, showing on every page his decided possession of the teacher's instinct. If he should find, by the time the fourth volume is out of press, that the first volume is much in need of revision, because of expansion and other changes in his laboratory, he will at least enjoy the satisfaction of having much good company in patiently performing the labor of Sisyphus and doing it well.

Dr. Millikan's book is a presentation of part of the work in general physics given to first-year students at the University of Chicago. It presupposes the possession of an abundance of apparatus of fine quality, all of which is thoroughly modern, and much of which has been designed and made initially for the Ryerson laboratory. The book is a combination of laboratory manual with class-room text. There are many teachers, therefore, to whom, on this account, the present volume will partially fail to commend itself. On such a subject no procrustean rules can be laid down, but each teacher must work out for himself the system of instruction by which he can attain the best results. Dr. Millikan's method is to divide his time nearly equally between class-room and laboratory work; but the former is wholly occupied with the discussion of the principles presented in the text and their application to practical problems. No demonstration lectures whatever are given until the last third of the year, when there is offered a discussion of those topics that have been omitted from the preceding courses because what is known about them is largely qualitative rather than quantitative. Such subjects as electrostatics, electric radiation, physiological optics and acoustics, the radiation, absorption, polarization and interference of light, are hence deemed suitable for initial

presentation in the lecture room rather than the laboratory. The student is assumed to have already completed a good high-school course, and the aim is not so much to acquaint him with interesting phenomena as to put him in touch with the methods and means of physical investigation. Whether the book can be profitably used by teachers of physics generally, by putting it into the hands of their students, it is not possible to make any positive assertion; but it can not fail to be very suggestive and otherwise useful to all whose range of duty coincides even in part with that of the author.

Professor Sanford's book is like that of Dr. Millikan in one important particular, that it is intended jointly as a presentation of theory and a laboratory guide. He believes the lecture-room method of imparting knowledge to be the poorest of all methods with elementary students, and his book has been written with the idea that it will not need supplementing by a lecture course. "It has been prepared especially for the teacher who has had an adequate training in the physical laboratory, and it is not likely to succeed with any other teacher." It is issued more especially for California students of high-school grade who compose a majority of the applicants for admission to the Stanford University; but it is evidently best suited for that increasing proportion of high schools in which the work encroaches largely on that of the college, and which seem destined within the next generation to supplant the small college in all except the thinly populated parts of our country. The author lays much stress on the importance of following in the laboratory the general method of scientific discovery, in which the acquisition of individual facts must precede generalization, while this in turn is followed by deduction and such special experimentation as is necessary to test its validity. Among the salient features of the book are the attempt to base the initial development of mechanics consistently upon the concept of energy, the discussion of the gaseous state of matter as a preliminary to that of the liquid and solid states, and in optics the complete elimination of 'the fiction of rectilinear propagation.' This last is a self-imposed and quite unnecessary limitation. If we admit the wave theory and the existence of wave fronts in a medium with known properties, the direction of propagation becomes as recognizable as the wave front, and it can scarcely be called a fiction unless the medium is also fictitious. The luminiferous ether may perhaps be still called a fiction, though one of great convenience and an intellectual necessity at present. Whether the wave front method or the ray method of explaining optical phenomena be preferred is a matter of convenience or of fashion. There can be no inconsistency in using both or either at will, and certainly each has its own advantages.

The volume by Messrs. Andrews and Howland presents no such departures from prevailing usage as the two just noticed. It is well balanced, well arranged and clear in style, but it contains no features that have not been exemplified in some of the better elementary class text-books in common use. The general plan of the authors has been to eliminate subjects that are of mere theoretic interest and to emphasize those that are practical; to use the simplest language possible and to avoid mathematical formulas in all cases where these are not absolutely necessary; to show as much as possible, for every subject selected, its relation to fundamental principles or their obvious corollaries.

Gage's 'Introduction to Physical Science' is a revised edition of a book that has been on the market since 1887. The author was at that time the well-known champion of the idea, at present advocated anew by Professor Sanford, that the student must be an inductive investigator. Mr. Gage now fully recognizes 'the consensus of opinion among teachers of physics that the method of instruction which includes a due proportion of text-book study, lecture-room demonstration and individual work in the laboratory is the method conducive to the highest order of results from an educational point of view.' The present volume is essentially a class text-book, and not a laboratory manual or a reading book for parallel private study. It is

scarcely necessary for the present writer to repeat what he has said in commendation of Mr. Gage's skill as a text-book writer, manifested in other books reviewed in the columns of SCIENCE. He is fully up to the standard set in those volumes.

The third group of text-books, intended for parallel reading or private study, is exemplified by the last three books on our list. This, perhaps, might be expected from the fact that the authors are writing for readers on the other side of the Atlantic, two of them being English and the third a Russian. There has been a distinctly American evolution of educational methods; and this fact, quite independently of any author's individual merit, causes few foreign text-books to be now available for text-book purposes in American schools, except for advanced students.

Lehfeldt's 'Text-Book of Physics' is written for students of medicine, and the author has endeavored, therefore, to exclude mathematical formulas as much as possible. The mode of arrangement is not to be commended, there being many long paragraphs and but little to aid the reader in singling out salient points. It is impossible to avoid formulas entirely, and these are incorporated quite frequently in the midst of the paragraphs, instead of being put separately and equationally so that mutual relations may be readily perceived. The book contains no problems. Chapter VI., entitled 'Chemistry,' is made up wholly of paragraphs in fine print on such subjects as the law of mass action, the phase rule, thermo-chemistry, and the relation of heat to chemical equilibrium. A single paragraph of this fine print, considerably more than a page in length, consists of seventeen sentences. The book was written with a view to attracting attention to the intimate dependence of physiology on physical principles, and is made up of the author's lectures to students preparing for the intermediate examination at London University.

Edser's 'Light for Students' is written by one who is far better versed in the art of book-making. The paragraphing is good. The illustrations, chiefly diagrams with white lines on a black ground, are clear and well selected. Mathematical formulas are used wherever necessary, and the deduction of them is usually in good shape, no knowledge of calculus being assumed. In discussing the wave theory the author recognizes the rectilinear propagation of light, not as a 'fiction' but as a resultant of wave motion, and light rays are assumed equally with wave fronts whenever suggested by convenience. Among the illustrations are several selections from Professor Wood's excellent photographs of air waves taken by the 'Schlieren-Methode.' Modern advances are noticed, including the production of stationary light waves by Wiener and Lippmann, the interferometer work of Michelson, and his echelon grating. The light phenomena accompanying electric discharges in high vacua come in for attention, X-rays being regarded as probably those of ultra-violet light of extremely short wavelength. The radiation from salts of uranium, polonium, actinium and radium is mentioned, but as the date of the preface is September, 1902, this subject is noticed more briefly than it would be to-day. The book is, on the whole, much to be commended.

The first volume of Chwolson's 'Physics' was published in 1897, at St. Petersburg, in the Russian language. A second edition appeared in 1900 and was brought to the attention of Professor Wiedemann at Erlangen. Appreciating its excellence, he took steps to secure its translation into German. This task was undertaken by Dr. Pflaum in Riga and the risk of publication assumed by Vieweg in Braunschweig.

Of late years two notable books on chemistry have come from Russians, the one by Mendelejeff, the other by Menschutkin; but neither could exert any important influence on the scientific world until freed from the shackles of an unspeakably difficult language. Chwolson's book is now in process of similar deliverance, and it has already received marked attention in Germany. The first volume, of nearly 800 pages in German, relates to the mechanics of gases, liquids and solids. The second, on acoustics and radiant energy, was to appear in Russian in 1898. The third relates to heat, and the fourth to

magnetism and electricity. The book has been written to meet the needs of university students, and in the first part it is assumed that the student has not yet had an opportunity to become acquainted with the methods of calculus; but this assumption is soon discarded.

The range of the first volume may be briefly indicated by an enumeration of subdivisions. After an introduction of fifty pages come the subjects of motion, force, work and energy, harmonic motion, radiant propagation of vibratory motion, universal gravitation, the potential theory, gravity. Then follows a section on instruments and methods of measurement, and separate sections on the theory of gases, theory of liquids and theory of solid bodies, the last including a discussion of elasticity and of friction. The style of presentation is clear and direct, and frequent brief summaries help the reader to seize upon fundamental principles. Each section closes with an index of literature relating to its subject matter.

Quite possibly the state of the American market may not warrant the translation of this excellent treatise into our language, but it is well worth the attention of those who are sufficiently interested to examine the German edition. W. LeConte Stevens.

SOCIETIES AND ACADEMIES.

BIBLIOGRAPHICAL SOCIETY OF CHICAGO.

A regular meeting of the Bibliographical Society of Chicago was held in connection with the annual meeting of the American Library Association on the afternoon of Wednesday, June 22, at Niagara Falls. After the president's address by Mr. A. G. S. Josephson, a paper on the 'International Catalogue of Scientific Literature,' by Dr. Adler was read. This paper is published above.

Dr. Herbert Haviland Field, of Zürich, was introduced and gave an account of the Concilium Bibliographicum founded in Zürich by the third International Congress of Zoology, in 1895. This institution collects and records all publications in biology, giving to each article separate cards of Library Bureau size. These cards aggregate at present twelve million for 150,000 titles, and thus constitute one of the largest, if not, indeed, the largest, collection of printed bibliographical cards. The Concilium Bibliographicum regards it as a technical triumph to have produced these cards for sale at the low price of one fifth cent per card. The cards are classified according to a methodical classification which is a development of the Dewey decimal system. For each topic found in the various publications there is a separate card published. In determining the various entries the text and not the title of the publication is considered, the number of entries for a single work often attaining ten or twelve. Besides supplying libraries and other institutions with complete sets of cards, the Concilium permits individual investigators to order cards for their own specialties. Thus the traveler going to Borneo could apply for the cards dealing with the fauna of Borneo. He would receive these at a nominal charge. In like manner any topic of investigation whatsoever can be asked for. The Institute is to-day nearly self-supporting, though it receives an annual subsidy of $1,500 from the Swiss Federal Government. It confidently hopes that bibliographers in America will lend it their support in obtaining similar financial aid in the United States.

Mr. Wilberforce Eames, of the Lenox Library, New York, presented a report in favor of the formation of an American Bibliographical Society and recommended that the Bibliographical Society of Chicago be authorized to take the initiative in the formation of the society. The report was adopted and active steps toward organization will be taken in the fall. Charles H. Brown,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE ST. LOUIS CONGRESS OF THE ARTS AND SCIENCES.

To the Editor of Science: In the May number of the *Atlantic Monthly* there appeared an article by Dr. Hugo Münsterberg, giving, in a quasi-official manner, a statement of the plans for the St. Louis Congress of

the Arts and Sciences. The fact that a literary rather than a scientific journal has been selected as a means of communication to the public, and that the plan itself as there set forth is philosophical rather than scientific, affords my justification for writing on a matter which my own technical scientific qualifications would under ordinary circumstances hardly entitle me to discuss, excepting possibly as respects one group of the sciences.

That the article bases the working plans of the St. Louis Congress of Arts and Sciences upon a particular methodology emanating from a particular school of metaphysics, not as yet numbering among its adherents any great number of either scientific men or philosophers, naturally arouses certain apprehensions. I write chiefly in the hope that some explanation may be forthcoming which will allay these apprehensions, which I find I am far from alone in feeling. Even after the explicit statements of the article, one can hardly believe one's own eyes, and is sceptical of one's right to attribute to the distinguished committee the notion of basing the Congress upon a particular scheme of metaphysical logic. One is sure the plan must be capable of construction in some other way. Accordingly I beg in advance the pardon of the committee if I should attribute to it in my following remarks a plan which as a matter of fact it has not fathered.

1. The article begins by setting forth an idea which is rational and feasible, and which would probably command general if not unanimous assent: the idea that the Congress should concern itself with the general aspects and bearings of the sciences, their relations to each other and to the unity of human knowledge and endeavor, rather than with purely specialized questions and researches.

2. Apprehension begins when we read: "The natural condition would be a plan in which every possible striving for truth, every theoretical and practical science would find its exact place. * * * It must be really a plan which brings the inner relation of all branches of knowledge to light * * * a ground plan which would give to every section its definite position in the whole system" (p. 674 of the *Atlantic Monthly* for May, 1903). It is repeatedly stated that the chief feature of the plan is that the arrangement of the sciences chosen is not one of practical convenience or effectiveness, but is one based upon a logical theory of knowledge. It is hardly necessary to point out the radical difference between a Congress which should work along the lines of the generalized aspects and interests of the sciences, and a Congress based upon a previously formulated and predetermined scheme of the unity of knowledge, or to dwell upon the *nonsequitur* from the first notion to the second. It is not the Congress of scientific and philosophical workers which is to bring to light (or bring nearer to the light) the unity and interrelation of the various movements of contemporary intellectual life. No, a necessary precondition of the work of the Congress is that it follow the lines of a predetermination of what the unity really is, a notion foreordained by a committee in charge of the Congress! One naturally asks the pardon of the committee for attributing to it even the passing fancy of a scheme at once so presumptuous and so futile.

3. As we read further we learn that this precondition of a 'ground plan' has been met, the committee having officially adopted a 'ground plan.' From the historical point of view, we learn from the article that contemporary intellectual life is officially decreed by the committee to have got beyond materialism, positivism, psychologism, indeed beyond any scheme in which the mental and physical sciences are coordinated with each other. The practical bearing of this appears when we are told that each department is to have an address on the historical development of its own line of work in the last century. It will certainly tend to decrease intellectual labor that each speaker know in advance the 'ground plan' of development which his own group of sciences has followed in the last century. There are still those, however (of whom I confess myself one), who would prefer to gather their ideas of what the actual historical move-

ment of the century has been from the results of the deliberate investigations of scientific leaders in a large number of fields, rather than to accept the conclusions of even so distinguished a body as the committee which has framed the plan for the Congress.

4. The 'ground plan' is also set forth in its logical scope and symmetry. There are five classes of sciences; the divisions being based upon the distinction, first between 'purposes' and 'phenomena,' and then between such purposes and phenomena as hold good for the individual and those which are more than individual in quality. There is we learn a radical gulf between purposes and phenomena. Purposes 'are not to be explained but to be interpreted' (*sic*, p. 677); they represent values which are to be appreciated, not described; they are to be approached by teleological not by causal methods (pp. 676–677). The student of art, history, literature, politics, jurisprudence, education, is, we are told, occupied with matters of this sort. Just what will happen to those students of art, history, politics, education, etc., who persist in considering that their concern is with phenomena, with their description and explanation, and who are desirous of employing psychological methods in this description and explanation, we are not told. Then 'phenomena and purposes' both subdivide themselves; each branches into those facts which are individual or hold only for one subject, and those which hold for every possible subject. The sciences which deal with the individual *phenomena* are the mental; those which deal with individual *purposes* are the historical. The sciences which deal with more than individual phenomena are the physical; those which deal with more than individual purposes are the normative, viz., metaphysics, logic, ethics and mathematics. Then we have a fifth class of sciences: those which deal with the relations between 'physical or mental, normative or historical facts on one side, and practical ends of ours on the other' (p. 678).

While it is somewhat confusing to discover in this fifth classification that purposes and norms turn out to be only facts, after all, and that even after we have gone through the sciences devoted to norms and purposes there still remain practical ends to be dealt with, yet the point that I here raise is not that of the ultimate value or final truth of this classification. The point is that it is a scheme characteristic of one limited school of philosophical thought. The real question at issue is the wisdom of basing a world's congress of arts and sciences upon any sectarian intellectual idea representing some particular *a priori* logic. Why should the committee take it upon itself to define the constitution of the unity of human knowledge, and to provide ready-made a plan or map of the interrelation of all its parts? Why is it not the business of the scientific and philosophical workers called together from all parts of the earth to consider, collate and present their own ideas about the structure and the divisions of the unity of human knowledge? Is it not the business of such a congress to further a consensus of judgment, or at least of inquiry, regarding just the features which the committee, according to the *Atlantic* article, has seen fit to prejudge and forestall?

One might also raise the question whether any scheme has a right to arrogate to itself the title of a 'ground plan' of the *unity* of human knowledge whose final result is to separate the psychological sciences from logic, esthetics and ethics, to separate all of these from the historical sciences, and the historical sciences in turn from the sociological sciences, and then to set up a fifth division of practical sciences to furnish 'links' for what has thus been chopped up! It would involve discussion of the merits of the particular plan proposed to argue that any plan which terminates in such arbitrary divisions has thereby experienced a *reductio ad absurdum*. But it is within the scope of the present discussion to indicate that such divisions, if they have any effect at all, can only operate prejudicially to the freedom and completeness of the intellectual discussions of the congress. The essential trait of the scientific life of to-day is its democracy, its give-and-take, its live-and-let-live character. Scientific

men of to-day are struggling hard and successfully to break down previously existing artificial walls separating different sciences, and to secure a continuous open and free field of inquiry. The most active sciences of the day have bifold names—astro-physics, physical chemistry, geo-physics, physiological chemistry, psycho-physics, social psychology, to take the first names that suggest themselves. Pick up the first authority that comes to hand upon the science of language: we read that language has two sides, meaning and form; that the explanation of meaning is a matter of psychology and of logic, while the problems of form are treated by phonetics and phonology which are a combination of physics and physiology. Turn to the committee's classification and we find that the science of language is officially recognized as a science of 'purposes,' not 'phenomena,' and hence excludes psychology. It is a science of *individual* purposes, and hence excludes logic. As a science of purposes, not phenomena, it also excludes physics or physiology or any combination of them. The case is typical, and conclusive of the fated practical inefficiency of a plan which attempts to arrange sciences—*i. e.,* branches of inquiry—according to *a priori* logic. The 'chance combinations of the university catalogue' in the laying off of the fields of inquiry may not conform to any existing 'ground plan' of metaphysical logic; but they have at least the modest merit of representing the vital activities of those engaged in the cooperative pursuit of truth and the building up of the working system of human knowledge.

The dilemma that presents itself after reading the article is the following: Either the scheme is one for presentation and discussion in literary and philosophical journals, not intended to have any influence upon the practical conduct of the Congress, or else it represents a theory of the constitution and divisions of human knowledge to which the various sections and subsections are really expected to conform themselves. In the first case, it is impossible to see why, in the *Atlantic* article, so much stress is laid upon the philosophical basis and aim of the Congress, upon the fact that it is an arrangement based not upon considerations of practical convenience, but upon a logic of knowledge. In the second case, the effect upon the Congress itself can only be disastrous. The imagining of some one invited to speak who does not accept the scheme, either in general or in its bearings upon the particular group of sciences which he is called upon to discuss, will serve as a convenient symbol for presenting the practical logic of the situation. Is he to decline because he can not accept the preordained formulations of the committee? If so, is such a result regarded as desirable from any point of view? Or is he to accept and to proceed with a complete ignoring of the 'ground plan' set forth? If so, what is the significance of the 'ground plan,' and how does the scheme in any way differ from one which should have based itself purely upon an empirical grouping of current lines of research made upon the basis of convenience?

John Dewey.

The University of Chicago.

CONCERNING THE WORD BAROMETER.

To the Editor of Science: In the issue of April 3, Dr. H. C. Bolton, quoting from Birch's edition of Boyle's Works, 1744, finds the word 'barometer' first used by Boyle in 1667, and he concludes that he probably used it as early as 1665.

In the issue of May 1, Mr. A. L. Rotch shows that Boyle did use the word as early as March 24, 1665.

I have before me the works of Robert Boyle, the title page of which tells us that the work was 'Printed for A. Millar, opposite Catharine Street in the Strand MDCCXLIV.' This edition is in five folio volumes and contains a preface by Thomas Birch dated London, November 16, 1743. It is not, however, the 'Birch' edition quoted by Dr. Bolton, as the page references do not coincide.

I find Dr. Bolton's quotations given on page 28 of Vol. III., and on p. 449 of Vol. II. The paper quoted by Mr. Rotch appears twice, first in Vol. V., p. 130, under the title as given by Mr. Rotch; second in Vol. II., p. 543, un-

der a slightly different heading and with the statement, 'First printed in the *Philosophical Transactions,* No. XIV., p. 256, for Monday, July 2, 1666.'

It is, however, when we turn to Robert Boyle's correspondence that the most interesting evidence on the subject is found.

1. In a letter by Robert Boyle to Mr. Henry Oldenburg, secretary of the Royal Society, dated March 19, 1665 (Vol. V., p. 250), he says: '* * * And to answer the former first, I wonder not there should be a mistake in the barometrical paper I sent you, the haste I was in having kept me from reading it over.' This letter doubtless refers to the paper presented to the Royal Society on March 24, 1665. This is, so far as I can find, the earliest use of the word by Boyle himself. It would seem from the context that it had been used before.

2. This conclusion is supported by letters to Robert Boyle. Thus (Vol. V., p. 471) Mr. John Beal, a fellow of the Royal Society, writes to R. B. on February 6, 1665, as follows: 'Persons of no ordinary capacities do find your three discourses of thermometers and baroscopes difficult.'

3. Mr. Henry Oldenburg writes on October 27, 1664 (Vol. V., p. 314): 'I did enquire at *Gresham* about the station of the barometer and was informed * * * .' This would seem to be in response to a request from Robert Boyle wherein he may have used the same term. (This letter of R. B.'s, if it exists, is not given.)

4. The person from whom Mr. Oldenburg in all likelihood made his 'enquiry' was Robert Hooke, who at this time was a resident of *Gresham* College and much interested in barometric work. In one of his letters to Robert Boyle I find the earliest use of the term under discussion. On October 6, 1664, he writes (Vol. V., p. 537): 'I have also, since my settling at *Gresham* College, which has been now full five weeks, constantly observed the baroscopical index (the contrivance, I suppose, you may remember, which shows the small variations of the air).' That the term is new to him is evidenced by his letter of September 15, 1664 (Vol. V., p. 536), in which he uses the term 'Torricellian' where 'barometrical' might have been used, also by his return to the older usage in his letter of December 13, 1664 (Vol. V., p. 542), wherein he says: 'I have lately observed many circumstances in the height of the mercurial cylinder * * * .'

To sum up: we find during the fall of 1664 a renewed interest and experimental activity in barometrical experiments. Associated in this work were *Robert Boyle, Henry Oldenburg, Robert Hooke* and others; thus *H. O.* writes to *R. B.* on September 1, 1664, as follows (Vol. V., p. 307): "On Monday last a club of our philosophers went to *Paul's* to make experiments of falling bodies, and of pendulums; there were Sir *R. Moray, Dr. Wilkins, Dr. Goddard, Mr. Palmer, Mr. Hill, Mr. Hook;* and some of them went to the top of the steeple and let down a pendulum of 200 foot long, with an appendant weight of — ℔., and found two vibrations thereof made in 15″. Time would not then give leave to proceed to the other experiments that were designed; among which will also be the Torricellian; but they will be set upon within two or three days." Robert Hooke's letters show the same activity. In the letters of this period we find three persons, and perhaps four, using the term as follows: Robert Hooke, October 6, 1664; Henry Oldenburg, October 27, 1664; John Beal, February 6, 1665; Robert Boyle, March 19, 1665. All these gentlemen had the requisite linguistic knowledge to coin the new word.

I am much inclined to think that the letter of John Beal given as of date February 6, 1665, should read '1666.' I thus conclude, first from the order of the letter, preceded as it is by one of date November 9, 1665, and followed by one of date March 31, 1666, and second, from references in the letter to Boyle's papers on thermometers and baroscopes, which papers must have been those presented or published during 1665, as I find no earlier date given for any of them. It is to be regretted that no letters from Robert Boyle are given from October, 1664, to March, 1665. Indeed the discussion of the question is in-

complete without an examination of the memoirs of both H. Oldenburg and Robert Hooke.

I am inclined to think, all things considered, that a complete survey of Robert Boyle's papers, were that possible, would show him to be the author of the word. A parallel case of word-making by him is found in the following letter to Mr. Oldenburg dated September 8, 1665, in which he says: " * * * that among some hydrostatical things I was once pursuing, I bethought myself of an easy slight instrument, which I called the measuring (or steriometrical) balance * * * " (Vol. V., p. 250). At all events Robert Boyle made the first public use of the word in his papers of March 24, 1665. Strict historical priority, however, must be given to Robert Hooke. The anonymous passage in the *Philosophical Transactions,* quoted by Dr. Bolton, I should be inclined to credit to the secretary of the Royal Society, H. Oldenburg, rather than to Robert Boyle.

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SHORTER ARTICLES.

ON A NEW LILAC-COLORED TRANSPARENT SPODUMENE.

THE mineral spodumene is generally known in large opaque whitish crystals, but occasionally it appears in small specimens that are transparent and richly colored. Such are the clear yellow gem-spodumene of Brazil,* the green variety hiddenite, or 'little emerald,' of North Carolina,† and the lilac or amethystine pieces rarely found at Branchville, Conn.‡ These last are plainly remnants of what must once have been elegant specimens; but spodumene is extremely subject to alteration, and has generally lost all its transparency and beauty of tint.

A notable discovery has just been made, however, of large splendid crystals of transparent unaltered spodumene, of rich lilac color, in connection with other lithia minerals, in San Diego Co., Calif. The locality is a mile and a half northeast of the town of Pala, and less than a mile from the famous rubellite and lepidolite mine at that place. Pala is already one of the most remarkable lithia localities known; amblygonite has been found there by the ton, and the lepidolite is estimated to occur by thousands of tons; while the pink rubellite crystals in the lilac lepidolite are familiar ornaments in every fine mineralogical cabinet.

At the new locality spodumene crystals occur up to the size of a man's hand, entirely clear, and of a rosy lilac tint, varying with the spodumene dichroism from a very pale tinge when looked at transversely to the prism to a rich amethystine hue longitudinally. If cut and mounted parallel to the base, these will undoubtedly yield gems of great beauty. No such crystals of spodumene have ever been seen before, and the discovery is one of extreme interest. A marked difference in color is noticeable also in these crystals, according as they come from some depth in the rock or lie nearer to the surface, the former having a deeper tint. This difference is doubtless due to the effect of air, water and light, which so frequently affect the color of minerals for some little distance into the rock. The material is exceedingly pure, with a hardness of about 7, and specific gravity (average of three crystals) of 3.183. The crystals are somewhat etched and corroded, and have a twinning, like the hiddenite variety, about the *a* (100) face; this is strikingly shown in the etched crystals, where the etching extends to the twinning-plane, and there stops.

Close to the opening, also, a splendid occurrence of colored tourmaline was found, some of the crystals being a foot long and three inches across, of rich pink rubellite with an exterior coating, or terminal caping, of dark blue indicolite.

Some similar, though smaller, crystals of transparent lilac spodumene were brought to the writer last winter, ostensibly from Hermosillo, Mexico; they were, however, found near Menchoir, California.

As this is an entirely new gem of a peculiar beauty, a name will be given to it as soon as its characteristics are definitely determined.

GEORGE FREDERIC KUNZ.

* Pisani, *Comptes Rendus,* 84, 1509, 1877.

† J. L. Smith, *Am. J. Sci.,* 21, 128, 1881.

‡ Penfield, *id.,* 20, 259, 1880.

THE WATER SUPPLY OF HAVANA, CUBA.

UNTIL recent years the water supply of Havana came from the Almendares River. During the nineties the present water works, deriving the entire supply from large springs at Vento on the south bank of the Almendares Rivers, was completed. The Vento Springs and the covered aqueduct leading its waters under the Almendares River and into Havana are the pride of the city of Havana which has erected an imposing monument to the engineer by whom the work was conceived. The Vento Springs are surrounded by masonry walls sloping outward from the springs except on the side nearest the Almendares River, where they are vertical. The surface water running down the slopes of the masonry is caught in a gutter which discharges it into the Almendares. At the top of the masonry and some distance removed from its margin another gutter catches the surface water of the region sloping toward the springs and discharges this also into the Almendares. The water flows direct from the spring into the covered aqueduct. The provisions for maintaining the water in its original purity from the time it issues from the ground till it is discharged, either into the reservoirs near the city or direct from the faucets in the city, are ideal.

There has been some speculation as to the origin of the water issuing from the spring at Vento. The water is beautifully clear and rather warm, having a temperature of 26° C. at the time of our visit. The Almendares River, flowing but a few feet away, also has clear water except after heavy rains, and its water at the time of our visit was slightly colder than that of the springs. It is possible that the Vento Springs derive their water from the upper courses of the Almendares, though this is so highly improbable that the suggestion may be left out of consideration. The springs being situated on the south side of the lower course of the Almendares, the region across the river—that is the region north of the river—may be excluded as a possible contributing source of the supply of the Vento Springs. The region about the springs is composed of coralline rock. In such porous material conditions under which territory on one side of a river may contribute to springs located on the opposite side of a river are impossible.

The most probable origin of the Vento water supply can best be understood after a general statement of the conditions of the surrounding region.

The southern slope of the provinces Guanajai, Havana and Matanzas is largely drained by underground streams. The streams arising in the hills and mountains, forming the watershed between north and south drainage, run above ground for a distance and then disappear underground. The Ariguanabo River thus runs into a bank at San Antonio de los Baños and disappears among fallen rocks. A few yards away from its 'sumidero' the water can be seen running in its underground channel through an opening in the thin roof of the channel. A few yards further on a dry cave leads down to the water, which at the end of the dry cave disappears among fallen rocks. Other rivers disappear in a similar manner. They can not be followed in their underground courses because they completely fill them. The underground waters and the channels in which they run can, however, be reached in places through sink-holes. The streams reappear, in part, at least, in a number of 'ojos de agua,' some near the coast south of San Antonio. The region drained by underground streams is comparatively flat, with frequently no indications of surface streams and their erosion, and extends westward to near San Cristobal where the first permanent surface stream is observed. At Artemisa and Candelaria stream beds contained pools of water in March, 1902.

From San Cristobal to Pinar del Rio there are many small perennial streams. Eastward from San Cristobal the cave region has an unknown extent. Poey limited it to the jurisdiction of Guanajay, but it certainly extends as far east as the meridian of Matanzas and from reports probably beyond Cienfuegos. East of Rincon there are, however, frequent river beds, all but one of which were dry during the time of our visit. This main cave region belonging to the southern slope

sends a tongue northward from Rincon to the Vento on the Almendares River in the northern watershed. Aside from the 'Ojos de agua' along the edge of the cienegas skirting the southern coast there are two notable places where underground rivers find an exit; the one at Vento, as already mentioned, supplies the entire city of Havana with its water, the other serves to make the region about Guines a garden, its waters being used for irrigation. Other subterranean rivers in all probability have a subaqueous exit to the south.

The large spring at Vento is the only one on the northern slope as far as I know. The exact origin of the supply issuing from the Vento Spring has not been traced. But the region north of the Almendares River, being shut out from a possible contributing source, it undoubtedly derives its water from the tongue of the system of underground streams thrust into the northern slope. An examination of the best available map and the levels of the Western and United Havana Railroads makes it seem quite certain that the Vento Springs derive their water from the region immediately south of Vento and north of Rincon and Bejucal. This region contains various sinks without surface outlets, as well as dry sink-holes. A notable sink-hole in this region is that at Aquada on the United Havana Railroad. This is very broad, shallow and dry during the dry season but the water rises to stand over ten feet deep on the railroad track during some of the wet seasons. All of these probably drain into the Vento Springs.

It behooves the health authorities of the city of Havana to exercise the strictest guard over the region between Vento on the north and Rincon and Bejucal on the south. Any contamination of sink-holes in these regions is sure, during the wet season at least, to contaminate the underground streams leading to Vento. An examination of the underground channels in the Lost River region of Indiana has shown the main underground channels to be provided with numerous smaller tributary channels which in ordinary weather do not carry water, but which do carry water into the main stream after a long rain. At such a time any filth that may have accumulated in any of the sink-holes over one of the tributary streams is sure to find its way into the main stream. The same is very probably true of the Vento supply, although on account of the nature of the region it is not possible to follow the underground channels. At present some of the sink-holes between Rincon and Vento are used as cess-pools and receivers of sewage.

C. H. Eigenmann.

NOTES ON PHYSICS.

GROUP AND WAVE VELOCITY.

The question was raised at the Pittsburg meeting of the American Association, in a private discussion of Professor Brace's scholarly vice-presidential address, as to the physical distinction between wave and group velocity of light. Undoubtedly the best physical discussion of this matter is to be found in the remarkable chapter on plane electromagnetic waves in Chapter IV., Vol. I., of Heaviside's 'Electromagnetic Theory,' especially in his discussion of the generation of tails. A simple conception of the distinction between wave and group velocity is as follows: Imagine a stretched rubber tube with a series of equidistant weights suspended from the tube by helical springs and imagine a train of say one hundred equidistant similar waves to be started along this tube. The head of this wave train, as it runs out at full speed (wave speed) upon the previously stationary portion of the stretched tube, exerts upon each element of the tube a series of periodic forces, and because of the suspended weights these periodic forces require some perceptible time, ten or fifteen cycles, say, to establish the full oscillatory motion corresponding to the full amplitude of the wave train. Therefore, although the head of the wave train runs out on the tube at full speed, there is a gradual rise in amplitude from the extreme head backwards towards the middle of the train. Furthermore, as the main portion of the wave train leaves a portion of the tube this portion of the tube persists for an appreciable time in oscillations of diminish-

ing amplitude because of the suspended weights, so that the advancing wave train leaves behind it an ever-lengthening tail, of which the amplitude diminishes backwards. The extreme head of the wave train travels at what is called the *wave velocity* and the middle of the spreading train travels at what is called the *group velocity*. Strictly, the term *wave velocity* applies to the ratio wave-length divided by periodic time in the middle region of a train of waves so long that the diminishing amplitudes in head and tail are without influence.

It is a curious fact, as has been pointed out by Heaviside, that a periodic wave train in a dispersing medium is about the only kind of wave that can be put into simple mathematics, while a mere wave pulse is the only kind that is simple physically. Physically a wave train in a dispersing medium is a very complicated phenomenon.

VARIATION OF WEIGHT WITH CHEMICAL AND PHYSICAL CHANGES.

The electromagnetic theory of inertia, in which the inertia of matter is attributed to corpuscular electric charges in the structure of atoms, leads one to expect a decrease in the total inertia of two substances like H and O when they combine to form water for the following reasons. A moving electric charge has inertia. The amount of this inertia is determined by the extent to which the electric lines of force from the charge permeate surrounding space, for this determines the extent of the magnetic field which is produced by the movement of the charge. Most of the inertia effect is, however, in the region near the charge, for there the electric field and also its magnetic effect are greatest. Two adjacent opposite charges side by side have less electrical inertia than the same two charges widely separated, for the reason that the electric lines of force permeate less into remote regions of space.

If inertia and gravitation vary together we should thus expect a given amount of O and H to weigh less when these substances are combined to form water.

Very careful attempts have been made to detect changes in weight due to chemical changes by Landolt in 1893 and by Heydweiller in 1900, and the changes are so small as to be questionable. Attention was called in 'Physics Notes' several years ago in Science to the fact that a variation of weight (or mass) with chemical changes would by no means necessarily vitiate the principle of the conservation of matter, so that such changes, if they exist, are of most importance in their bearing upon the perplexing questions of gravity and inertia.

Recently it is announced that Professor Babcock has established the fact of the variation of weight with chemical and physical changes. He is reported to have used a special form of hydrostatic balance capable of detecting a change in weight of one part in a hundred million. This degree of refinement is in fact about that which can be reached by the ordinary balance, and when we remember that the temperature of his water-bath would, unless compensating devices are devised and used, have to be controlled to about 1/40,000 of a centigrade degree to enable him to avail himself unmistakably of a sensitiveness of one part in a hundred million, it seems doubtful that he could have realized a sensitiveness anything like as great as that at the disposal of Landolt in 1893, at the disposal of Heydweiller in 1900 and also at any one's disposal now in 1903. When the buoyant force of the air, only, is involved temperature must be controlled to about 1/400 of a centigrade degree to enable one to detect unmistakably so small a variation in weight as one part in a hundred million.

W. S. F.

RESOLUTIONS OF THE NATIONAL EDUCATIONAL ASSOCIATION.

The committee on resolutions at the Boston meeting of the National Educational Association, which consisted of Nicholas Murray Butler, of New York, Chairman; Andrew S. Draper, of Illinois; James M. Green, of New Jersey; Bettie A. Dutton, of Ohio; H. B. Frissell, of Virginia; prepared the following declaration, which was adopted by the association.

1. The United States Bureau of Education has amply proved its usefulness to the nation. Its publications are standard works of reference for school officers and teachers everywhere. The Bureau of Education should be made an independent administrative department, such as were the Departments of Agriculture and of Labor before their elevation to Cabinet rank. Sufficient appropriations should be made by the Congress to enable the Commissioner of Education to extend the scope and add to the usefulness of his work.

2. The condition of affairs in the Indian Territory, where fully three quarters of the population are reported as being without schools for their children, demands the immediate attention of the Congress. Provision should be speedily made by which the people of the Indian Territory will have power to establish and carry on a system of public schools so that all classes of citizens in the Indian Territory may have the educational opportunities which are enjoyed by their fellow-citizens in other parts of the country.

3. Teaching in the public schools will not be a suitably attractive and permanent career, nor will it command as much of the ability of the country as it should, until the teachers are properly compensated and are assured of an undisturbed tenure during efficiency and good behavior. A large part of the teacher's reward must always be the pleasure in the character and quality of the work done; but the money compensation of the teacher should be sufficient to maintain an appropriate standard of living. Legislative measures to give support to these principles deserve the approval of the press and the people.

4. The true source of the strength of any system of public education lies in the regard of the people whom it immediately serves, and in their willingness to make sacrifices for it. For this reason a large share of the cost of maintaining public schools should be borne by a local tax levied by the county or by the town in which the schools are. State aid is to be regarded as supplementary to, and not as a substitute for, local taxation for school purposes. In many parts of the United States a large increase in the amount of the local tax now voted for school purposes, or the levying of such a tax where none now exists, is a pressing need if there are to be better schools and better teachers.

5. The highest ethical standards of conduct and of speech should be insisted upon among teachers. It is not becoming that commercialism or self-seeking should shape their actions, or that intemperance should mark their utterances. A code of professional conduct clearly understood and rigorously enforced by public opinion is being slowly developed, and will, doubtless, one day control all teachers worthy of the name.

6. It is important that school buildings and school grounds should be planned and decorated so as to serve as effective agencies for educating not only the children but the people as a whole in matters of taste. The school is becoming more and more a community center, and its larger opportunities impose new obligations. School buildings should be attractive as well as healthful, and the adjoining grounds should be laid out and planned with appropriateness and beauty.

7. Disregard for law and for its established modes of precedure is as serious a danger as can menace a democracy. The restraint of passion by respect for law is a distinguishing mark of civilized beings. To throw off that restraint, whether by appeals to brutal instincts or by specious pleas for a law of nature which is superior to the laws of man, is to revert to barbarism. It is the duty of the schools so to lay the foundations of character in the young that they will grow up with a reverence for the majesty of the law. Any system of school discipline which disregards this obligation is harmful to the child and dangerous to the state. A democracy which would endure must be as law-abiding as it is liberty-loving.

THE AMERICAN ELECTROCHEMICAL SOCIETY.

The fourth general meeting of the American Electrochemical Society will be held at Niagara Falls, N. Y., September 17, 18 and 19, 1903. Thursday and Friday afternoons will be devoted to visits to power houses and

certain of the electrochemical plants which are open to visitors, and to other points of interest in the vicinity.

Thursday evening there will be a smoker and entertainment. Friday evening a dance and reception at the Cataract House. Saturday evening will be devoted to a trip to Niagara-on-the-Lake, Youngstown and Port Niagara by boat and trolley.

The following titles of papers have been announced:

P. G. SALOM: 'A New Type of Electrolytic Cell.'

DR. GEORGE P. SCHOLL: 'Manufacture of Ferro-Alloys in the Electric Furnace.'

DR. W. D. BANCROFT: 'Electrolytic Copper Refining.'

DR. W. H. WALKER: 'Electrometallurgy of Gold.'

F. A. J. FITZGERALD: 'Some Theoretical Considerations of Resistance Furnaces.'

F. AUSTIN LIDBURY: 'On the Supposed Electrolysis of Water Vapor.'

PROFESSOR O. W. BROWN: 'Efficiency of the Nickel Plating Tank.'

CARL HAMBUECHEN: 'Electrolysis of Sodium Hydroxide, by Alternating Current.'

PROFESSOR C. F. BURGESS: 'A Practical Utilization of the Passive State of Iron.'

DR. E. F. ROEBER: 'The Present Status of the Theory of Electrolytic Dissociation.'

C. J. REED: 'Berthelot's Law of Electrochemical Action.'

Other papers are expected from Dr. J. W. Richards, David H. Browne, Dr. L. Kahlenberg, Professor C. F. Burgess, A. H. Cowles and others. One session of the meeting will be devoted to the discussion of the theory of electrolytic dissociation, which will be opened by Dr. W. D. Bancroft.

It is announced that "negotiations have now been practically completed for supplying to all members free the Transactions of the London Faraday Society (the recently formed British Electrochemical Society), which are published in the *Electrochemist and Metallurgist* issued monthly. This is to be accomplished by supplying our Transactions free to the members of the Faraday Society. There will be no increase in our annual dues on account of this free exchange, and the benefit to be derived by our members is obvious. It is also evident that this new arrangement entails considerable additional expense upon our society. The continuance of this agreement will require not only the greatest economy in the administration of our funds, but also the active support of our individual members in maintaining and increasing our membership."

SCIENTIFIC NOTES AND NEWS.

THE following honorary doctorates have been conferred by the University of Heidelberg, on the occasion of the centenary of its reopening: Mathematics, M. G. Darboux, Paris; physics, Dr. R. T. Glazebrook, London; astrophysics, Sir William Huggins, London; chemistry, Professor S. Cannizzaro, Rome; mineralogy, Professor F. Fouqué, Paris; astronomy, Professor E. C. Pickering, Harvard University; zoology, Professor E. Maupas, Algiers; botany, A. Cogniaux, Nivelles.

DR. F. R. HELMERT, director of the Geodetic Institute at Potsdam, has been elected a foreign member of the Turin Academy of Sciences.

A *Festschrift* is in course of preparation to be presented to Professor J. P. Pawlow on the twenty-fifth anniversary of the beginning of his scientific work, which occurs next year. It is proposed at the same time to endow in his honor a prize for research in physiology.

A BRONZE medal is to be struck in honor of Professor Cornil, of Paris, to commemorate his work on the history of pathology and bacteriology.

PROFESSOR O. ISRAEL has been appointed curator of the Pathological Institute of the Berlin Charity Hospital.

DR. KARL SCHÖNBERG has resigned the chair of surgery at the University of Würzburg, owing to a stroke of paralysis.

DR. STUHLMAN has been appointed director of the Biological and Agricultural Institute at Amani in German East Africa.

DR. ROSANES, professor of mathematics and physics, has been elected rector of the University of Breslau.

Dr. Kolthoff with a party of Swedish naturalists will begin this year an exploration of the northern parts of the Pacific Ocean, starting from Port Arthur.

Dr. D. T. MacDougall, director of the laboratories of the New York Botanical Garden, has returned from a trip to Jamaica in the interest of the garden. Dr. M. A. Howe, assistant curator, has been in Porto Rico, and Mr. George V. Nash has been in Hayti, on a similar mission.

According to *Nature* the following American and other foreign corresponding members of the British Association have signified their intention of being present at the Southport meeting: Professor G. S. Atkinson, Cornell University; Dr. Von Bebber, Hamburg; Dr. R. Billwiller, Zurich; Professor Ludwig Boltzmann, Vienna; M. Teisserenc de Bort, Paris; Captain Chaves, St. Miguel, Azores; Mr. W. Davis, Cordoba, Argentine; Professor G. Gilron, Louvain; M. A. Gobert, Brussels; the Comte A. de Gramont, Paris; Professor Hellman, Berlin; Professor H. Hergesell, Strassburg; Professor H. H. Hildebrandsson, Upsala; Professor Lignier, Caen; Professor C. Lombroso, Turin; Dr. T. P. Lotzy, Leyden; Mr. G. G. MacCurdy, New Haven, Conn.; Professor E. Mascart, Paris; Professor H. Mohn, Christiania; Professor Willis Moore, Washington, D. C.; Professor Simon Newcomb, Washington, D. C.; Professor L. Palazzo, Rome; Professor Paulsen, Copenhagen; Professor J. M. Pernter, Vienna; Dr. A. L. Rotch, Blue Hill Observatory, Mass.; General Rykatcheff, St. Petersburg; Professor M. Snellen, Utrecht; Professor R. H. Thurston, Cornell University; Dr. H. C. White, University of Georgia; Professor E. Zacharias, Hamburg.

We regret to note the following deaths among foreign men of science: Dr. Emmanuel Munk, associate professor of physiology at Berlin, on August 1, at the age of fifty-one years; Dr. C. K. Hoffman, professor of zoology and comparative anatomy at Harlem, on July 28, at the age of sixty-two years; Dr. N. Bugajew, professor of mathematics at Moscow, at the age of sixty-six years; Dr. Franz Schwackhöfer, professor of chemical technology in the school of agriculture in Vienna, on July 18, at the age of sixty-one years; Dr. Sigmund Fuchs, professor of physiology in the same school, on July 30; Professor Karl Hausknecht, of Weimar, the botanist, on July 7.

Official statistics have been published giving the enrollment of members at the Boston meeting of the National Educational Association, which reached the remarkable total of 32,757. The distribution of members in attendance is of considerable interest, as many as 3,748, for example, going from Illinois, and the total number from the north central states reaching 14,545. Scientific men of the Atlantic seaboard object to a meeting of the American Association for the Advancement of Science or of our other national scientific societies in the central states, and members from the central states do not attend meetings held in the east in very large numbers. It seems that we have much to learn from the spirit and organization of the National Educational Association.

The government of New Zealand will assist the Australasian Association for the Advancement of Science, which meets at Dunedin next January, in several ways. A sum of £500 will be appropriated towards the expenses of the meeting; the government printer will do all printing required by the association free of cost; railway passes will be issued to members; and any assistance that it may be in the power of the permanent departments of the government service to render to the association will be afforded.

The International Geological Congress opened its sessions at Vienna on August 20. A large number of American geologists went abroad this summer with the intention of attending the congress.

Pursuant to the action of the Seventh International Geographic Congress held in Berlin in 1899, the geographers and geographic societies of the United States are considering plans for the ensuing congress, which is to convene in September, 1904. It is proposed to have the principal scientific sessions in

Washington early in the month, and to have social sessions in New York, Philadelphia, Baltimore and Chicago, with a final session in conjunction with the World's Congress of Science and Arts in St. Louis. It is provisionally planned also to provide an excursion from St. Louis to Mexico, and thence to points of geographic interest in western United States and Canada. A preliminary announcement is in press and will shortly be issued to officers and members of geographic societies in all countries, and to geographers who may express interest in the congress and its work. Details have been entrusted to a committee of arrangements made up of representatives from geographic societies in all parts of the United States. The officers of the committee are: Dr. W J McGee (vice-president National Geographic Society), chairman; Mr. John Joy Edson (president of the Washington Loan and Trust Company), treasurer; and Dr. J. H. McCormick, secretary. The office of the committee is in Hubbard Memorial Hall, Washington, D. C., where communications may be addressed.

THE sixth annual session of the American Mining Congress will meet at Deadwood and Lead, South Dakota, beginning on September 7.

THE fourteenth annual meeting of the British Institution of Mining Engineers will be held in the University College, Nottingham, beginning on September 2.

THE ship *Terra Nova* has now sailed from Dundee to relieve the *Discovery*. The British government, which has appropriated £45,000 for the expedition, is apparently acting without the advice of the Royal Geographical Society and the Royal Society, which originally sent the expedition, assisted by a grant from the government. Mr. Balfour in the House of Commons criticized the societies for not foreseeing the difficulties into which the *Discovery* has fallen, but afterwards withdrew his criticism as far as the Royal Society is concerned. At almost the same time the *Fritchjof* sailed from Sweden for the relief of the expedition under Professor Nordenskjold. The Swedish parliament has appropriated $50,000 for this purpose.

THERE will be a civil service examination on September 23 and 24 for the position of draftsman in the U. S. Geological Survey, with a salary of $1,400 a year. The examination will consist chiefly of practical work, retouching photographs for photoengraving and pen-drawing from photographs.

P. BUDIN in his report to the Commission de Depopulation on infant mortality gives statistics, which are summarized in the *British Medical Journal*. In Paris 145 out of every 1,000 deaths are of children under a year old, and in St. Pol-sur-Mer the proportion is as high as 509 per 1,000. During the years 1896–1900 the average annual mortality of children under one year in France was 134,434; in fact the proportion of death to survivors of the same age was higher for the first year than for any other year below the 91st. The report first discusses the direct medical causes of this mortality. The three most important are infantile diarrhoea, respiratory diseases, and congenital debility. Of these, infantile diarrhœa accounts for far the greatest number of deaths. Out of every 1,000 infants dying in Paris 380 die from diarrhœa, in Rouen 510, in Dijon 584, in Troyes 682. The system of feeding is the most important factor in this result. Of 69 children dying of diarrhoea at Boulogne, 8 only were breast-fed children, 20 were bottle-fed, and to 41 solid food had been prematurely given. The diarrhoea of breast-fed children is caused by excessive and irregular feeding. Bottle-fed children are often enormously overfed, a fault which acts most injuriously in hot weather, when least food is needed. The milk given is often of bad quality, containing bacteria, adulterated, or wanting in cream. The chief cause of death amongst congenitally weak children, especially if they are undersized, is exposure to cold. The feeding of these children requires skill. If too little food is given they become cyanosed and die, if too much they succumb readily to diarrhœa. Coming next to non-medical conditions tending to increase infant

mortality, Budin states that the death-rate is abnormally high among illegitimate children and those whose lives have been insured, and also among children of working women who are obliged to entrust them to the care of others, whether paid or unpaid. On the other hand, the mother who feeds her own child at the breast may almost always expect to rear it, in the absence of special risks, such as an alcoholic tendency on the part of the mother, which of course affects the milk. The reduction of an excessive infant mortality is a question of obvious importance in a country which, like France, has a stationary or declining population; and in suggesting remedies, most of which follow directly from the causes to which the excessive mortality is assigned, Budin demands state intervention as well as more intelligent individual effort. Every mother who can do so should be induced to suckle her own child. The importance is urged of mothers bringing the children each week to a doctor to be weighed and inspected. These consultations are of the utmost benefit wherever doctors feel it their first duty to secure that all mothers shall, if possible, suckle their children. Where the mother's milk is insufficient, some sterilized milk may be supplied, but complete artificial feeding should be deferred as long as possible. Budin himself sees about 100 children weekly in this way, and during four years not one under his care has died from diarrhœa. Other suggestions are: (1) That women be not allowed to go to work for a month after delivery, compensation to be given during this time; (2) that a nursing mother be allowed to leave work twice a day to feed her child; (3) that municipalities ensure the good quality of milk sold; (4) that the manufacture and sale of long-tubed bottles be made illegal; (5) the inspection of all children not under the care of their parents; (6) the treatment in hospital of prematurely born children below a certain weight; (7) the prohibition of the insurance of infants.

UNIVERSITY AND EDUCATIONAL NEWS.

The Lord Mayor of Liverpool has proposed that a tax be levied to cover the expenses of the University of Liverpool, and that tuition should be made free in all departments. Should this plan be carried into effect, Liverpool would be the only university in Great Britain without tuition fees.

The *Journal of the American Medical Association* states that all the medical schools in the country now have a four years' course, this having been adopted by three schools in 1902 and this year by the last school with a three years' course.

It is said that plans have been perfected for combining the faculties of medicine of Toronto and Trinity Universities.

The following were recently appointed as assistants in the department of histology and embryology at Cornell University: Wm. A. Hilton, Ph.D. (Cornell); S. G. Winter, A.M. (Ohio), and Geo. W. Partridge, A.B. (Rochester).

Charles H. Shaw has been appointed adjunct professor of botany in the department of pharmacy of the Medico-Chirurgical College, Philadelphia.

Dr. Ernst Steinitz has been elected professor in the Technical Institute at Charlottenburg, in the room of the late Professor Hamburger.

The Royal Commissioners for the exhibition of 1851 have made appointments to science research scholarships for the year 1903, on the recommendation of the authorities of the several universities and colleges. The scholarships are of the value of £150 a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any university at home or abroad. The scholars are to devote themselves exclusively to study and research in some branch of science the extension of which is important to the industries of the country. Fifteen new scholars are appointed, fifteen scholars are reappointed for a second year and six for a third year. Two of the students who are reappointed will study in the United States—Mr. G. B. Waterhouse at Columbia University and Mr. T. C. Hebb at the University of Chicago.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 4, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE U. S. MARINE HOSPITAL SERVICE.**

GENTLEMEN: I beg leave to express my pleasure in meeting you at this assemblage, called by myself in accordance with section 7, of the act of congress approved July 1, 1902.

What may be the result of these annual conferences time must determine, but certainly we may consider the present, the first annual conference under the law, as a most noteworthy event. For the first time in the history of the United States there has been placed within its statutes, by the act of Congress referred to, a provision looking to harmonious and cooperative efforts in public health matters between the national government and the state governments.

This status has long been desired, but difficult of achievement by reason of our republican form of government. It has been difficult for the national government to extend its influence into state health matters without appearing to infringe upon the states' authority, and it has been difficult for the states, individually or collectively, to seek aid from the government without appearing to surrender authority reserved to them by the national constitution. In the meantime, however, the

* Opening address before the first annual conference of State and National Health Authorities, Washington, D. C., June 3, 1903.

Marine-Hospital Service, now bearing the title of the Public Health and Marine-Hospital Service of the United States, has become so developed and strengthened, and the state health organizations have been so perfected, that a sentiment of respect, one for the other, has been established, finding its expression in this law of 1902, and, in particular, section 7 above referred to.

To my mind the outlook is bright. The great problems to be solved in sanitary affairs; the great work to be done in the suppression, and even elimination, of disease, and the cultivation of health and strength, so that physically, as well as in other respects, the United States may take a leading position among the nations, are propositions which should not be considered impossible of solution, and a proper development under the terms of this law will be an important step in this solution.

One of the most important features of this assemblage is its official character. All of us are familiar with conventions of similar purpose, productive of much useful information but entirely lacking in official significance. Here, however, are assembled the legalized health authorities of the states, representing the practical administrative experience as well as the theoretical and scientific knowledge required in the consideration of public health affairs.

Many of you have devoted the best years of a long professional life to the consideration of the subjects which will come before us, having acquired, in individual instances and on special subjects, unusual knowledge and wisdom.

Combined effort appears to be a distinguishing feature of this new twentieth century. This is seen in nearly all forms of civic and commercial life and even scientific and professional effort. It would seem that when the history of the twentieth century is written there will be lacking those great and single characters looming far above the average, leading, directing or dictating; instead, there will be an elevation of the average, the best individual effort will, neither in purpose nor effect, aggrandize the individual, but will be exerted in connection with other effort of like nature for the establishment of a parity of well-being among all. This, I take it, will be the keynote of our action, bearing constantly in mind the actual results to be attained and being determined to attain them.

To refresh your memory I will now read section 7 referred to, and also section 8, which is somewhat analogous.

It will be seen that section 7 provides for three kinds of conferences. First, the surgeon-general may invite as many of the health and quarantine authorities as he deems necessary, not more than one from each state, territory or District of Columbia, to a conference, whenever in his opinion the interests of the public health would be promoted thereby. Second, a conference must be called at least once a year of all the states, territories and District of Columbia. Third, upon the application of not less than five state or territorial boards of health, quarantine authorities or state health officers, he must call a conference, but in this event only those states joining in the request are to be called.

While the present is the first annual conference, it is not the first conference called under the law. Last January, upon the request of twenty-two states, a so-called plague conference was called to consider the situation in San Francisco. The proceedings of that conference in detail have been transmitted to each of you. The effect of it was undoubtedly very great in

bringing about the present satisfactory status in San Francisco. The object of that conference was specific, but, as you will note, the law providing for the annual conference gives no details. We must assume, therefore, that the intent of the law is that we shall get together, and we are to decide ourselves as to the matters to be considered. It is evident that the conference is advisory in character, without changing in the least the present executive force of this bureau of the Treasury Department.

It seems advisable at the outset, and for a satisfactory understanding of one another, to give a review of the laws and of the organizations relating to the Public Health and Marine-Hospital Service, and to receive in return an account of the same nature from each state delegate.

The laws especially relating to the United States Public Health and Marine-Hospital Service can be found listed in the appendix to the regulations of the service of 1902, and the laws relating to quarantine can be found printed in full in the quarantine regulations of 1903.

Having thus referred to the laws, I propose now to describe the organization of the Bureau of the Public Health and Marine-Hospital Service. For executive administration, the bureau is divided into six divisions, each presided over by an assistant surgeon-general. There is, also, a miscellaneous division, presided over by an assistant surgeon, and the office of the chief clerk. The clerical force numbers about twenty. These divisions are named as follows:

Division of Marine-Hospitals and Relief.
Division of Domestic Quarantine.
Division of Foreign and Insular Quarantine and Immigration.
Division of Sanitary Reports and Statistics.
Division of Personnel and Accounts.
Division of Scientific Research.
Miscellaneous Division.

DIVISION OF MARINE-HOSPITALS AND RELIEF.

To this division are sent all matters relating to the marine-hospitals, 22 in number owned by the service, and to the patients, numbering 58,000, treated annually in these hospitals and in some 110 relief or contract stations. The Purveying Depot, a large building located in New York, is under the direction of this division, to which are also referred all matters relating to hospital supplies, including subsistence, drugs, hospital furniture, surgical instruments and appliances, plans and specifications for hospital construction, and the conduct of the sanatorium for consumptive patients at Fort Stanton, New Mexico, where the service has a sanatory ranch, 56 square miles in area, the buildings of the fort having been placed in perfect condition, the patients in the sanatorium numbering about 150. The scheme for this ranch embraces the removal of consumptives from our hospitals with a view to their improvement or recovery. Quite a large percentage have recovered, a number leave greatly improved, and all who desire can find employment after leaving in the same high, dry and healthy locality. The hospitals are thus relieved from this contagious disease, and the vessels from which they come are subject to inspection and disinfection as to their forecastles or other quarters that have been occupied by known consumptive patients.

DIVISION OF DOMESTIC QUARANTINE.

To this division are referred all matters relating to the national maritime quarantine stations, embracing nineteen complete disinfecting stations and eighteen inspection stations. At the former are hospitals, barracks, disinfecting machinery, steamers

and small boats, all requiring constant care and attention. This division, also, must see to the expenditure of appropriations for new stations, involving purchase of lands, construction of piers and buildings, said construction being generally under the supervising architect of the treasury on plans approved by the bureau and the department; but occasionally the bureau attends to this construction itself. To this division are also referred all matters relating to the quarantine regulations and their interpretation. Matters relating to interstate quarantine and suppression of epidemic diseases are also handled in this division. Quarantine upon the Mexican and Canadian borders is also conducted through this division.

DIVISION OF FOREIGN AND INSULAR QUARANTINE AND IMMIGRATION.

To this division is assigned the management of the national quarantine stations in Hawaii, Porto Rico and the Philippine Islands, the supervision of officers detailed for duty in the offices of the United States consuls in foreign ports, who sign the bills of health with the consuls. At present there are three officers in Japan, Yokohama, Kobe and Nagaski; two in China, Shanghai and Hong Kong; one in Naples, Italy; ten in Cuba, three in Havana, one each at Cienfuegos, Santiago, Nuevitas and Matanzas, and several at sub-ports; four in Mexico, two in Vera Cruz, one at Progreso, and one at Tampico; six in the fruit ports of Central America, namely, Bocas del Toro, Colombia; Port Limon, Costa Rica; Bluefields, Nicaragua; Ceiba and Puerto Cortez, Honduras; Livingston, Guatemala; and Belize, British Honduras.

To this division are also referred all matters relating to the medical inspection of immigrants, a most important function of the service, requiring the detail of a large number of officers.

DIVISION OF SANITARY REPORTS AND STATISTICS.

This division is charged with the preparation of the public health reports, published weekly by the bureau. All matters of a statistical nature are referred to it.

It may be of interest to state that some question has arisen as to whether the work of this division which is authorized both by the law of 1893 and the law of 1902, may not duplicate the work of the Census Bureau, but I am pleased to state that, after conference with the Chief Statistician of the Census Bureau and others connected therewith, it has been found that there need be no duplication or interference by one bureau with the other; on the contrary, each will be helpful to the other. The Census Bureau, in addition to the decennial census, will publish an annual census of mortality and births, but the weekly and monthly reports will be published as heretofore by this bureau, and morbidity reports, which are so much desired and which will require special organization to procure, will be undertaken by the Public Health and Marine-Hospital Service.

DIVISION OF PERSONNEL AND ACCOUNTS.

To this division are referred all matters relating to the personnel of the service, examinations for admission to the corps of commissioned officers; examinations for promotion, appointments and resignations, appointment of boards for the physical examination of officers of the Revenue-Cutter Service. This division has also charge of the bookkeeping of the service.

DIVISION OF SCIENTIFIC RESEARCH.

This division might be better called the Division of Scientific Research and Sanitation. To it are referred all matters relating to the hygienic laboratory. It should be understood that this laboratory, or the staff thereof, is not a part of the bureau proper, though at present located in

the same building. A new building, however, is just completed, located on the grounds of the old Naval Observatory, about half a mile west of the White House on the river bank. Five acres of this tract were turned over from the Navy Department for the establishment of this laboratory. It will give the director of the laboratory great pleasure to arrange with the delegates to this conference to show them this building. The laboratory has an advisory board, consisting of a delegate from the army, not yet named, Dr. Urie, of the navy, Dr. Salmon, chief of the Bureau of Animal Industry; Professors Welch, of Johns Hopkins; Flexner, of Rockefeller Institute; Sedgwick, of the Massachusetts Institute of Technology; Vaughan, of the University of Michigan; and Wesbrook, of the University of Minnesota. Under the law of 1902, three new divisions were added to the laboratory, the Division of Bacteriology already existing. These three new divisions are those of zoology, chemistry and pharmacology. But one of these new divisions has been organized, namely, that of zoology, and the good results of this new organization are manifested in the recent discoveries and published report of the chief of this division, Dr. Stiles, upon the 'Prevalence and Geographical Distribution of the Hookworm.' Bulletins, embodying important results of investigations, are published from time to time under the supervision of the Director of the Laboratory, Dr. Rosenau. It is believed that congress can be influenced to provide for the extension of this laboratory by the erection of new buildings from time to time as the necessity therefor becomes demonstrated.

To this Division of Scientific Research and Sanitation are referred special requests for scientific investigation of special diseases, as for example the recent investigation of the so-called spotted fever in Bitter Root Valley, Montana. The initiatory steps for special investigations of this character are taken in this division, but any prolonged or technical work connected therewith is turned over to the laboratory.

Requests for special investigations of water pollution or local causes for the spread of typhoid fever are referred to this division.

The officer in charge of this division examines all current literature relating to scientific medicine or sanitation and keeps a card index of the same.

MISCELLANEOUS DIVISION.

The Miscellaneous Division has charge of the mailing of all bureau publications, and certain miscellaneous duties relating to the reports of necropsies from the marine-hospitals, the medical examination of claims for benefits on account of injuries received by the crews of life-saving stations, certain matters relating to the annual report, etc.

Under certain bureau orders the operations of these several divisions are coordinated so that the work of one division, when it affects the personnel or duties connected with another division, is accomplished with the full knowledge and acquiescence of the other. There are also two regular bureau boards for the careful consideration of matters referred to them —namely, the Service Board and the Sanitary Board.

YELLOW FEVER INSTITUTE.

There is one other feature of the bureau, assigned to no one particular division, but embracing all, namely, the institute for the study of yellow fever, called the Yellow Fever Institute, with which most of you are familiar. This institute was founded about two years ago for the purpose of

learning all that could be learned about yellow fever, including its etiology, and to bring to this work the aid of all reputable physicians who might desire to take part therein, its membership including, besides the officers of the Marine-Hospital Service, special investigators both in this and foreign countries. It is divided into four sections, the chairman of each section being one of the division officers of the bureau to which, under bureau organization, matters of a kindred nature would naturally come. These, together with the chairman and secretary of the institute, form an executive board to consider, especially with regard to publication, the contributions received from the members. Twelve bulletins have been issued. A thirteenth, and the most important of all, relating to the cause of the disease, is now being printed and will be ready for distribution within a few weeks. This bulletin contains the report of a working party sent to Vera Cruz last summer to investigate and attempt to find the causative agent of the disease. Their work was continued during the winter with the material obtained in Vera Cruz, and gives evidence that progress has been made toward a final result. A second working party of three, two of whom were in the first party, are now in Vera Cruz and vicinity pursuing a continued investigation, and it is the purpose of the institute to continue in the prosecution of this work until successful. This institute embraces new features in the investigation of the cause of a specific disease, and if it proves successful with regard to yellow fever it may be that the new features of organized effort which it embraces will be applied to the investigation of other diseases.

Other important matters engaging the attention of the service are the proposed legislation for the establishment of a national leprosarium in which may be received the occasional cases of leprosy found in the states, which give the local and state authorities so much trouble; also the enforcement of the new regulations relating to the examination and licensing of establishments for the production of vaccine, serums and antitoxin, under the law passed by the last Congress. These regulations go into effect next August.

Mention should also be made of the connection of the service with the International Sanitary Bureau of American Republics, established in accordance with resolutions of the Conference of American States held in the city of Mexico winter before last.

THE MEDICAL CORPS.

Finally, with reference to the service work, I wish to say a few words with regard to the medical corps, consisting of 109 commissioned medical officers received into the corps only after a thorough examination as prescribed by law, appointed first to the lowest grade, and promoted to the higher grades only after further successful examination. The discipline of the corps is military in character, the regulations for its uniforms and government are prescribed by the President, its officers, by reason of unusual responsibilities, continuous medical and surgical care of the large clientele, and by special scientific instruction in its hygienic laboratory, are kept in the van of professional excellence. There are, however, nearly two hundred acting assistant surgeons, some of whose appointments are temporary in character, but a number of whom have been long in service by reason of special adaptability or because the arrangement made with them is necessary in the interest of economy. These officers of the medical corps are stationed in all parts of the United States

and its dependencies, and constitute our reliance not only in the ordinary work of the service but in times of special need.

CONFERENCE ORGANIZATION.

I have deemed it necessary to give this somewhat extended account of the organization of the service, both that our aims and methods may be understood and that I may the more readily explain a proposed method of making these annual conferences of practical utility. It might be advisable to appoint on special committees members of the conference especially interested in the several subjects to be considered by these committees, said committees to remain in organization during the year and to receive for further conference with the Surgeon-General such matters as might be pertinently referred to them by him. The titles of these committees would find their analogues in the several divisions of the bureau. The reports of these committees could be read to the full conference at its annual meeting, and, if adopted by the bureau and the conference, would have a force and influence which would naturally result from the conjoint action of the national and state authorities. I would suggest tentatively the following committees: First, on Scientific Research and Sanitation, second, on the Prevention and Spread of Epidemic Diseases, third, on Morbidity and Mortality Statistics, fourth on State Legislation, fifth, on Education. In addition to these, there might be special committees on certain specified diseases, namely, cholera, yellow fever, plague, smallpox, tuberculosis, leprosy, typhoid fever. To these committees might be committed such resolutions as may be offered here, but the adoption of any resolutions by this conference, it seems to me, should not be until after a report thereon had been made by the special committee to which it is referred.

It is believed that the above plan is at least worthy of trial. It would give real aid and would stimulate the members of the committees in an investigation of the subjects confided to them, and might produce a uniformity of effort, a coordination of work in different parts of the country, which now does not obtain.

WALTER WYMAN.

U. S. PUBLIC HEALTH AND MARINE-HOSPITAL SERVICE.

*THE GENERAL EFFICIENCY OF TECHNICAL EDUCATION.**

DOUBTLESS when an alumni address became a part of our commencement program, it was intended that it should be directed more especially to you, gentlemen of the graduating class, and should be in the nature of a professional welcome from one of your older brothers. You were to be welcomed into the ranks of the engineering profession by one who, not so very long before, had passed through the same strenuous preparation which you are just finishing and who had since become a successful engineer. Unfortunately, I have no such claim to your attention, having wandered from the true faith in which we are all trained here, and it is, therefore, impossible for us to meet on the common ground of your future labors. Instead, it has seemed a not inappropriate thing for us to examine briefly your past work; more specifically, to consider the general value and efficiency as a preparation for life, of the technical education which old Rose has given you, and to compare its general influence and value with that of the very different, so-called 'liberal' education which the regular college or university gives.

Technical and liberal educational sys-

* Alumni address at the commencement exercises of the Rose Polytechnic Institute, June 11, 1903.

tems have radically different ends in view and proceed by quite different methods. The one is specific and definite, preparing men for special fields of activity; the other broader and more general, aiming to give men good ideals, good ambitions, a properly balanced judgment and well-trained mind—items of equipment which are sure to be useful to any man in any walk of life. It has been said that one trains men to live, the other to earn a living. If we accept this as roughly defining their respective characteristics, then it is evident that a combination of the two is the ideal to be sought after. At present, however, it is usually a question of one *or* the other, and colleges of engineering and of liberal arts are coordinate parts of our universities—a fact somewhat grudgingly admitted by those representing the older learning. I think we shall find good reason for their attitude.

In comparing things so different, it is important to select the best points for comparison, and it is obvious that we need not consider matters of purely technical significance. That is to say, when it comes to designing a bridge, it is evident that as a preparation no amount of Latin or history can be considered as an efficient substitute for a course in graphical statics. But it being impossible to foresee the exact future of any student, there is left considerable scope for general strength and adaptability which even the most technical educational method must take into account and seek to provide for. Comparison between liberal and technical training may well be made, then, as regards just this point, the success with which they fit men to grow and to adapt themselves to new and more exacting conditions. But there is another consideration. Every man owes something to himself and to the community which cannot be paid by even the best executed professional services. He owes it to the community that he should be willing and able to discharge successfully the responsibilities which in one form or another are sure to fall upon him; and he owes it to himself and to the community that he should see more in life and get more out of life than lies within his purely technical horizon. It is, therefore, again appropriate to inquire as to the relative success with which the two educations aid men in satisfying these last-mentioned demands, which are essentially general.

It is usual to conceive of any educational scheme as having two fairly distinct aims, which President Hadley has called training for knowledge and training for power—perhaps an unfortunate choice of words in view of the adage 'Knowledge *is* power.' But the meaning is clear—teaching to *know*, and teaching to *think* and *do*. To these should be added a third, less easy to define—teaching to *appreciate*, that is the cultivation of the tastes. The traditional liberal education of the last century was largely an education for power, that is, the stress was laid on mental discipline, training of the memory and logical faculties as contrasted with the imparting of knowledge. The subjects studied, however, largely classical literature and philosophy, naturally and unavoidably fulfilled in a measure the third requirement above mentioned. The characteristic feature was, nevertheless, the hard drill along certain well-defined lines, the infliction on all students of certain definite tasks. At present, however, a liberal education means quite a different thing. The one-sidedness of the old scheme, together with the great increase in the number of possible subjects of study, has led to what seems an almost equally one-sided development in the other direction—namely, the universal preponderance of elective over required studies. It is as if the college or university should greet the prospective student with the

statement: "Here is our collegiate bill-of-fare; a fine array of courses with which, if you choose properly, you can satisfy your proper appetite and at the same time be disciplined as we know you ought to be disciplined. However, help yourself to what you want—we shall interfere only in case of violent indigestion." In spite of traditions to the contrary, then, and in spite of ample opportunities for hard work, a liberal education may come to consist too largely of the imparting of information and cultivation, with not enough mental discipline, and not enough hard work. Indeed, student opinion, quick to detect a weakness and caricature it, has already adopted the name 'culture-course' for an easy-going snap.

The above à la carte scheme, if you will allow the term, contrasts strongly with the table d'hôte service universally found at technical institutions. These have, by a curious paradox, fallen heir to the rigid disciplinary method of the old schoolmasters. As we all know, there is very little latitude in a technical course, once the general aim of the course is decided upon; much of the work requires a good memory, and more important, clear thinking—and students are forced to do it whether they like it or not. The student, in his laboratory work, is constantly confronted with problems the solution of which develops self-reliance and independence, and there is opportunity for him to try his hand at 'knowledge-making.' There is, therefore, little need to worry about the efficacy of technical training as regards *power*, except in one important particular. Training for *power* aims not at the production of the graduate who shall be most immediately successful in the particular work which he first undertakes, but rather one who shall have, as has been said, the greatest capabilities for growth. This means that principles rather than details should be taught; that an independent, self-reliant grasp of a subject should be given, rather than facility in special methods. The recent graduate, thrown for the first time entirely on his own responsibilities, frequently resents this, and is disposed to argue that he should have been taught all the details of the particular machine he is first called upon to design or the special points of the particular lighting system he first has under his control. But he soon learns the short-sightedness of such a policy. Again, any extended engineering career involves extended and varied intercourse with men; to be successful in this demands character and knowledge of men and institutions. There is little of the formal training of the engineer which directly aims to satisfy this demand; and while it is also true that much of it must come from association rather than from formal teaching, still the value in this respect of a curriculum based on the so-called humanities is amply shown by the output of the English universities and the older and more conservative institutions of this country.

Turning now to the other two groups into which we divided the aims of education, we find, of course, that the technical training is here much less efficient. The knowledge embodied in the course is almost entirely special and technical, such as forms a necessary basis for the discipline already outlined. The general or 'humanities' side may be represented only by a relatively small amount of two modern foreign languages, a little economics or political science and English. A narrow basis, surely, for the broad activities, the general intercourse and the contact with men which are features of a successful engineering career. It is a pity that men whose disciplinary training has been so well calculated to bring out their best abilities, to train them for control and leadership,

should in any way be hampered by a narrow outlook or ambition. It has been said, on the other hand, that since engineers deal more particularly with materials and physical relations rather than with men, it will never be demanded or expected of them that they should have any particular knowledge of men or of human institutions, such as is necessary in other more humanistic professions. In other words, that an engineer will be just as successful whether he be a broad man or a narrow man, since all the public wants him for is to build a bridge or a railroad, or perform whatever other special service he is fitted for. This is too narrow a view, for two reasons: (1) The educational level is rising, and the engineer must at least keep pace with the general improvement. (2) Engineers are taking such an increasingly prominent part in the life of the country—engineering undertakings are so closely allied to questions of public policy, public economy and social order, and the matter of immediate utility is so closely involved with that of permanent value and fitness—that the public can not afford to intrust its engineering undertakings to any but broad men.

If technical training is deficient as regards broad knowledge, it is still more so as regards the culture side, which is left practically untouched. Moreover, there is very likely to be a desire on the part of the students still further to reduce the time spent in such work, the argument being that it is not sufficiently 'practical,' and doesn't 'pay.' I believe it does 'pay,' even in a commercial sense—but what if it does not? Is there nothing there worth having except for the profit it will bring? The word we have used to represent this side of education—culture—is in bad repute even among those representing its best phases. To some it means a veneer, a smattering of music, art or literature; a sort of young-ladies'-finishing-school halo of accomplishments. Again it may imply a somewhat exclusive but genuine learning and an air of condescension toward every-day life and work. Both mistaken notions, of course. What the word should imply is a genuine interest in something for its own sake, and a determination to know and appreciate the best there is of that something—whether it be literature, music, amateur photography or tennis. The broader the interest, the greater the intelligence and the self-sacrificing labor necessary to appreciate and attain the best, just so much broader and more thorough is the culture which it represents. Matthew Arnold put the matter in a compact and surprisingly practical form when he defined culture as 'the disinterested pursuit of perfection'; it is a point of view, an attitude, a motive which has its influence on every action.

It is apparent, then, that technical education as at present understood is strong in the matter of the discipline of the mind and will; it will help a student to think clearly; it will give him self-confidence and self-control, and teach him the virtue of and necessity for work. It is equally apparent that the system is weak on the side of broad general knowledge and cultivation, and there can be no doubt that this is a serious defect. There are three possibilities for improvement. The first is to devote more time during the technical course to subjects of a general character. It is doubtful whether this can be done to any great extent in view of the constantly widening technical field; but I believe some improvement could be brought about, and at least we as alumni should be cautious in urging or suggesting any reduction in the minimum time now allowed. Again, the burden of providing this part of the engineer's education may be pushed down on the preparatory schools. This means

raising the requirements for admission, that is the general as distinguished from the technical requirements. The student's preparation in the high school or academy should be complementary rather than introductory to his later work, those subjects being omitted which will be thoroughly taken up in the college course, in favor of languages and other subjects which can not be so well studied later. But this rearrangement and extension of the preparatory course must not involve any material increase in the entire time required to obtain the bachelor's degree, for our graduates, as compared with those in Germany, are quite old enough under the present arrangement.

Finally, student activities and intercourse which make up the characteristic college life furnish an opportunity of supplying the general training which is lacking. Indeed, if the statements of some over-enthusiastic college presidents be accepted, to the effect that participation in college life is the chief end in attending college, we might logically conclude that the differences between a liberal and a technical education could be entirely made up by the proper introduction of dormitories, fraternities and a reasonable amount of hazing. Without going so far as entirely to deny the value of the regular curriculum, we must admit that intercourse with fellow students and participation in various student enterprises may be of tremendous benefit, if these activities are rightly directed and carried on, and such activities, particularly along lines very different from the routine work, should by all means be encouraged. This encouragement can be the more freely given because student enterprises are far less likely to be carried to an extreme among engineering students than among others, simply because they have less time for such things. This simple fact of having plenty to do, effectively answers, almost before they are raised, many of the questions which are most difficult to deal with in connection with student life at other institutions of a different character. For instance, outdoor sport with you has not entirely ceased to be play, and the view still finds favor that athletics exist for the benefit of the students, rather than that the student body exists to 'root' for a winning team.

In ways like these will it become more and more true, let us hope, that the engineering graduate has had the essential features of a liberal education in addition to his professional training. That such is not the case at present should be frankly admitted. The danger is that the graduate should not realize the limitations of his training, and should not in the future be at all interested in making up its deficiencies; that his judgment as to the values of an education be based too largely on the consideration as to whether or not it 'pays.' Such a one-sided point of view is, I am glad to believe, rare among us. We are all proud of the good name of our alma mater; we appreciate that the rank of an institution is in large measure determined by the success of its graduates; and we are earnest in our endeavor to win such recognition in our specialties as shall be worthy of, and if possible bring additional honor to, old Rose. But do we fully grasp the fact that we are called upon to be broad men as well as specialists, and that there is a sort of success to be attained quite distinct from our professions? I trust that we do, and I hope that the R. P. I., without losing in the least its good repute as a trainer of expert engineers, may more and more be known as a trainer of men.

W. C. Mendenhall.
University of Wisconsin.

JOHN ELFRETH WATKINS.

The sudden death in New York city on August 11 of Dr. J. Elfreth Watkins, for many years Curator of Mechanical Technology in the U. S. National Museum, is a severe loss to that institution and, indeed, to the world at large, for his great knowledge of the early history of the beginnings of mechanics, especially in our own country, had made him an accepted authority on such subjects.

Dr. Watkins was born in Ben Lomond, Va., on May 17, 1852, and was a son of Dr. Francis B. Watkins and Mary Elfreth. On his father's side he was descended from Thomas Watkins, who during the War of the Revolution contributed his influence and money towards the raising of a troop of cavalry of which his son became captain. On his mother's side he was descended from Timothy Matlack, 'the fighting Quaker,' who was a member of the Committee on Safety in Pennsylvania, and after participating actively in the War of the Revolution, was a delegate to the Continental Congress during the years 1780 to 1787; also on his mother's side he was descended from John Elfreth, who served in the Philadelphia City Troops in 1814.

Young Watkins received his academic education at Tremont Seminary in Norristown, Pa., and then entered Lafayette College, Pa., where he was graduated in the scientific course in 1871, taking the degrees of C.E. and M.S. For a year after graduation he served the Delaware & Hudson Canal Co. as mining engineer, and then entered the employ of the Pennsylvania Railroad as assistant engineer of construction, being stationed at Meadows Shops, N. J., where he remained until 1873, when he was disabled for further field work by an unfortunate accident that resulted in the amputation of his right leg. On his recovery he was assigned to the Amboy division of the Pennsylvania road, and served in various capacities during the ten years that followed. In 1883 he was appointed chief clerk of the Camden & Atlantic Railroad, and a year later was assigned to a similar office on the Amboy division of the Pennsylvania Railroad, which place he then held until 1886.

The history of the beginnings of mechanical arts in the United States, especially in connection with the development of transportation, attracted his attention and he became a close student of that subject. He soon met the late Dr. G. Brown Goode, a Virginian like himself, and at Goode's suggestion he received an appointment in the National Museum as Honorary Curator of Transportation, which place he accepted in 1884, and at once began the work of organizing that division which now contains some of the most valuable exhibits of the museum.

Two years later he severed his connection entirely with the Pennsylvania road, in order to devote his entire time to the museum, and continued as curator until 1892. The knowledge which he had acquired with special reference to the early history of the Pennsylvania Railroad led to an invitation which he could not refuse, to return to the service of that corporation, and to organize the exhibits made by them at the World's Columbian Exposition in Chicago. These exhibits were of unusual interest, including the original locomotive, 'John Bull,' and many other historic objects, and of them he prepared a catalogue, which formed a volume of almost two hundred pages, which was published by the Pennsylvania Railroad in 1893.

At the close of the World's Fair in Chicago, the Field Columbian Museum was organized, and it was at once apparent that the proper man for the directorship of the Department of Industrial Arts was Dr. Watkins, and he was immediately called to that place, where he remained for one year

organizing the department. The ties that bound him to the National Museum were too strong to be completely severed, and accordingly in 1895 he returned to Washington, resuming his office as Curator of Mechanical Technology, which place he continued to hold until his death, as well as that of Superintendent of Buildings, which his early training as an engineer made him most competent to fill.

The information that he acquired naturally led to the publication of numerous papers, and among these may be mentioned 'Beginnings of Engineering' (1888); 'The Development of the American Rail and Track' (1889); 'The Log of the Savannah' (1890); and 'Transportation and Lifting of Heavy Bodies by the Ancients' (1898). It culminated in his being chosen to prepare the history of the Pennsylvania Railroad, 1845–1896, a series of quarto volumes descriptive of the first fifty years of that railroad, which is beyond doubt the most complete history of the beginnings of railroad transportation in the United States.

As his reputation increased, he became more and more widely known as the great American authority on the history of mechanical arts, and in recognition of his work in this direction, the Stevens Institute of Technology conferred upon him the degree of Doctor of Science. He served as a juror on his specialty at the expositions held in Atlanta, Omaha and Buffalo.

Dr. Watkins was exceedingly loyal to the city of Washington. He was the moving spirit in the Patent Centennial that was held in Washington in 1891, acting as secretary of the executive committee, and had much to do with the volume that was subsequently published. He also served on various committees in connection with the inaugurations of the presidents and of the centennial celebration of the capitol. He was a member of the Cosmos Club, the American Society of Civil Engineers, the Society of Colonial Wars, the Society of Sons of the Revolution, the Society of the War of 1812, of which he was for some time treasurer, and the Washington Philosophical Society, of which he was for many years secretary.

Following the custom that has prevailed on similar occasions a meeting of the officers and employees of the Smithsonian Institution was held on August 12, for the purpose of taking action on the death of Dr. Watkins, and the following minute prepared by a committee consisting of Dr. Cyrus Adler, Mr. W. de C. Ravenel and Professor W. H. Holmes was adopted:

> In the death of J. Elfreth Watkins, the Smithsonian Institute is deprived of the services of a loyal, able and intelligent official; the foremost authority on the history of transportation and of the mechanical arts in America; and a man whose reputation extended far beyond the confines of his own country. He pursued his scientific and administrative labors under physical infirmities which would have crushed the ordinary man, yet he had the heart and found the time to be kind and helpful to every one with whom he came in contact, from the humblest to the highest. He was the founder of the collection of transportation and of the history of invention now in the National Museum, and from his pen there were contributed many notable memoirs on these subjects. He was upright, hospitable, generous, and leaves behind him the memory of a conscientious official, an upright man, a patriotic American, a notable contributor to scientific literature and a sense of personal bereavement on the part of all who have ever had the good fortune to be associated with him. His colleagues and friends extend to his widow and his children their deepest sympathy in this great bereavement, with the expression of consolation which the contemplation of the life and deeds of such a man must afford to those who loved him.

Marcus Benjamin.

SOCIETIES AND ACADEMIES.

THE TEXAS ACADEMY OF SCIENCE.

At the regular meeting of the Texas Academy of Science held in the Biological Lecture Room of the University of Texas, April 17, 1903, Mr. Robert A. Thompson, president of

the academy and expert engineer to the State Railroad Commission, delivered an illustrated lecture upon 'Mechanical Interlocking Devices at Railroad Crossings.' Fifty views taken in various parts of the United States were used to show the value of these mechanisms in the matter of safety to trains and in the gain of time—factors of the greatest importance in modern railroading. Dr. Eugene P. Schoch, instructor in chemistry in the university, explained from a recent point of view 'The Effect of Carbon upon Steel.'

The second formal meeting of the year was held in the Chemical Lecture Room of the university on June 10, 1903, at 3:30 P.M. The program on this occasion was as follows:

Dr. Harry Yandell Benedict, Associate Professor of Mathematics in the University of Texas: 'An Ideal History of Experiments on the Regular Pentagon.'

Dr. Eugene P. Schoch, Instructor in Chemistry in the University of Texas: 'Two New Lecture Experiments in Physical Chemistry.'

Thomas U. Taylor, Professor of Applied Mathematics in the University of Texas: 'The Northwest Boundary of Texas.'

Augusta Rucker, M.A., Instructor in Zoology in the University of Texas: 'A New Texan Kœnenia' (by title).

Dr. William L. Bray, Associate Professor of Botany in the University of Texas: 'The Vegetation of the Sotol Country' (by title).

A. M. Ferguson, M.S., Instructor in Botany in the University of Texas: "Some Recent Discoveries Concerning the So-called Ant 'Mushroom Gardens'" (by title).

Dr. Frederic W. Simonds, Professor of Geology in the University of Texas: 'Notes on the Topography of Texas' (by title).

The ballots having been counted, the following officers were declared elected for the year 1903–4:

President—Dr. Edmund Montgomery, Hempstead.

Vice-President—Dr. William L. Bray, Austin.

Treasurer—Mr. R. A. Thompson, Austin.

Secretary—Dr. H. Y. Benedict, Austin.

Librarian—Dr. William T. Mather, Austin.

Members of the Council—Hon. Arthur Lefevre, Superintendent of Public Instruction; Dr. H. L. Hilgartner and Dr. S. E. Mezes.

Frederic W. Simonds.

DISCUSSION AND CORRESPONDENCE.

THE INTERNATIONAL CONFERENCE OF ARTS AND SCIENCE.

To the Editor of Science: I have read with much interest the letter of Professor Dewey with respect to Professor Münsterberg's classification of the sciences. Several months ago there fell into my hands the enclosed copy of a 'Preliminary Program for the Official Addresses at the International Congress of Arts and Science' of the forthcoming exposition at St. Louis in 1904. Since this remarkable document is marked '*Confidential*, Proof under Revision,' it has been so treated by me up to the present date.

In the meantime, Professor Münsterberg, in an article on 'The St. Louis Congress of Arts and Sciences,' published in the *Atlantic Monthly* for May, 1903, has acknowledged himself as the author of the classification of the sciences set forth in the 'Program' and has led his readers to infer that this classification has been provisionally if not definitely accepted by the congress. He writes as a member of the 'Committee on Plan and Scope' of the congress and as the special representative of the 'philosophical sciences.' To quote his own words, he 'steps up to the honored platform of Park Street,' wherever that may be, 'and tells a wider circle what those plans are, and why they ask for interest and favor.'

We may perhaps doubt whether Professor Münsterberg speaks for the entire committee referred to, but since his explanation and defense of the 'Program' has been thus before the public for upwards of three months, it seems proper to assume that he invites criticism of his scheme of classification of the sciences from a larger circle of thinkers than that which centers in Park Street. I beg, therefore, to second Professor Dewey's invitation of the attention of the readers of Science to this matter and to submit a few brief remarks thereon.

The criticism which Professor Münsterberg's classification of the sciences seems to require is aimed not so much at the scheme itself as at the extraordinary claims he makes

for it. Any scheme that is workable may do well enough for the mere purposes of an international congress. But he would have us or, at any rate, the literary audience to which he addresses his exposition, believe that he has at last solved one of the great philosophical riddles. "The real interest," he says, "lies in the logic of the arrangement. The logical problem how to bring order into the wilderness of scientific efforts has fascinated philosophers from Aristotle and Bacon to Comte and Spencer. The way in which a time groups its efforts toward truth becomes, therefore, also a most significant expression of the deeper energies of its civilization, and not the least claim which our coming congress will make is that the program of its work stands out as a realization of principles which characterize the deepest strivings and the inmost energies of our own time as over against the popular classifications of the nineteenth century." Thus does the new scheme triumph over all difficulties!

If this were true, or even in part true, the scheme would be very important to men of science. Unfortunately, however, a glance at the divisions and subdivisions of the scheme seems to reveal only another of the numerous systems of *à priori* philosophy carried to the extremes which border on absurdity.

It is needless to discuss in detail a scheme at once so pretentious and so vulnerable. One should see a copy of the 'Program,' or read the exposition of it in the *Atlantic Monthly*. I will only add, Mr. Editor, that while we may not go out of our way to oppose philosophers and literary folks who indulge in such extravagances, it is our duty to repudiate them when they appear in the public press in the guise of science; for they tend only to make science and scientific men ridiculous.

R. S. WOODWARD.

ANTARCTICA.

TO THE EDITOR OF SCIENCE: If Dr. Mill will look anew through 'Antarctica,' he will be unable to find one line criticizing him. I spoke of him necessarily in my letter (SCIENCE, July 10), because he happened to review the monograph. I can assure him I am most pleased with his review and his letter (SCIENCE, August 7) for they help in forcing the facts about antarctic exploration to the notice of scientists. Gradually the truth will be recognized.

That some English geographers persist in ignoring American antarctic explorers is once more demonstrated in the July *Geographical Journal*. In the sketch map of the National Antarctic Expedition, on which the ink is hardly dry, the name of Wilkes Land is omitted as usual. Clarie Land appears once more, regardless of the fact that there is no Clarie Land. D'Urville called some ice cliffs Côte Clarie but he did not see the land behind them, which was discovered, however, a few days later by Wilkes, and which he named Cape Carr. The name of Graham Land is applied again to the land massif which was known as Palmer's Land for about ten years before Biscoe's voyage. I suggested that the name West Antarctica be given to that region, partly in the hope of reconciling international prejudices.

The final suggestion of Dr. Mill deserves unqualified approval. Would it not be possible to send an American expedition, either private or governmental, to reexplore the coast of Wilkes Land? A steamship like the *Bear*, commanded by naval officers, should be able, in the course of one southern summer, to bring back fresh data about the land discovered by Americans in East Antarctica.

EDWIN SWIFT BALCH.

YORK HARBOR,
August 10, 1903.

SHORTER ARTICLES.

KUNZITE, A NEW GEM.

DURING an extended investigation on certain optical properties of the Tiffany-Morgan Gem and Bement Mineral Collections in the American Museum of Natural History it has been my privilege to examine the new lilac-colored transparent spodumene described by Dr. Geo. F. Kunz in SCIENCE, August 28.

Mineral spodumene is usually obtained in large opaque whitish crystals, but from time to time small specimens, often richly colored

and transparent, are found. The three characteristic varieties of the latter are a clear yellow gem spodumene of Brazil,* the green hiddenite or 'little emerald' of North Carolina,† and the lilac sometimes found in Connecticut.‡ These are without doubt remnants of large specimens, which must have been elegant. Spodumene is very subject to alteration and has usually lost all its transparency and beauty of tint.

Kunz (*loc. cit.*) described some large and magnificent crystals of unaltered spodumene, of rich lilac color, which have recently been discovered near Pala, San Diego County, California, in connection with certain other lithia minerals. It has been my good fortune to see and handle from this locality massive spodumene crystals ($10 \times 20 \times 4$ cms.) perfectly clear, of a rose lilac tint, varying with the spodumene dichroism, from a very pale tinge when observed transversely to the prism, to a rich amethystine hue longitudinally. No such crystals of spodumene have ever been seen before and the discovery is of great mineralogical interest. The crystals have been etched by weathering and have a twinning like the hiddenite variety. The mineral, when cut and mounted parallel to the base, gives gems of great beauty. The chemical analysis, which is under way in my laboratory, will shortly be published.

The observations of Dr. Kunz sufficiently characterize this mineral of peculiar beauty as a new gem, which he has not named. I have submitted large crystals to the action of ultra-violet light without any evidence of fluorescence or phosphorescence. When subjected to bombardment of the Röntgen rays of high penetration for several minutes no fluorescence is observed, but on removal to a dark chamber it exhibits a persistent white luminosity not observed with this class of minerals, as learned by experiments with altered and unaltered spodumene from the localities mentioned, including cut stones and such handsome crystals of hiddenite as afforded by the collections mentioned. I have been able to excite a crystal ($2 \times 4 \times 10$ cms.) by the action of the X-rays for five minutes sufficiently to cause it to photograph itself when subsequently placed directly upon a sensitive plate (thin white paper being interposed) and allowed to remain in an especially constructed padded black box in a dark room for a period of ten minutes. The material is penetrated by the rays as shown by a cathodograph. The excitation is not superficial, but persists throughout the mass. On account of this unusual and characteristic phosphorescence, as well as the other properties, I propose the name *Kunzite,* for reasons unnecessary to give to American and European scientific men. The mineral material and cut gems may be seen at Tiffany and Co.'s or the American Museum of Natural History, New York.

Charles Baskerville.

August 12, 1903.

* Pisani, *Comptes Rendus*, 84, 1509, 1877.

† J. L. Smith, *Am. J. Sci.*, 21, 128, 1881.

‡ Penfield, *Am. J. Sci.*, 20, 259, 1880.

THE TOXIC EFFECT OF H AND OH IONS ON SEEDLINGS OF INDIAN CORN.

Within the last five years or so some attempt has been made to determine the toxic effect of various chemical solutions upon plant life. This involved the theory of ionization, which is based upon the electrical conductivity of solutions.

When acids, bases or salts are put into solution, they separate, more or less completely, into molecules or part molecules of their elements, or into groups of two or more atoms of different elements which are very strongly united. Molecules which exist in this state are known as ions—*e. g.,* if 100 molecules of HCl were put into solution they would separate to form H ions and Cl ions, and probably there would be some HCl ions left, depending upon the strength of the solution. If NaOH were put into solution a like separation would take place except that OH ions and Na ions would be formed in place of the H ions and Cl ions.

All compounds do not permit total dissociation at the same dilution. "Solutions of hydrochloric, nitric and sulfuric acids are nearly completely dissociated when an equivalent in grams is dissolved in 1,000 liters of

water." * "Solutions of hydrochloric, nitric and sulfuric acids are practically completely dissociated when an amount of these compounds in grams equal to their molecular weights divided by the number of H atoms (one gram equivalent) is added to one liter of distilled water."†

These statements are contradictory. Though the former states HCl is nearly completely dissociated at $n/1000$ and the latter states that the same acid is practically completely dissociated at a normal solution, yet both are incorrect; but to be exact it is also practically completely dissociated at a concentration four times $n/1000$ dilution, $n/250 = 98.9$.‡

Other weaker compounds may have some undissociated ions—*e. g.*, NaCl at a certain dilution is 80 per cent. dissociated; that is, if there were 100 molecules of NaCl and 80 per cent. of them were dissociated there would be 80 Cl ions and 80 Na ions and 20 NaCl ions.

The degree of dissociation increases as the dilution increases until a dilution is reached when the dissociation is practically complete.

Since the degrees of dissociation in compounds capable of dissociation vary with the dilution, it is necessary to find the degree of dissociation before it is possible to determine the exact toxic effect of each kind of ions in the various solutions—*e. g.*, if a seedling just lives in a solution of KOH 1/128 gram equivalent dissolved in distilled water and made up to 1,000 c.c., and dies in a NaOH solution of the same dilution, one of two things must be true,—either the degree of dissociation in KOH is less than the degree of dissociation in NaOH at the above-named dilution or the Na ions have an appreciable toxic effect at this dilution, but it has been stated by MacDougal§ that at such weak dilutions sodium salts have no appreciable influence, hence the difference in the toxic effect of the two solutions must be due to the difference of dissociation.

It has been stated that it is the H ions and those containing H which are fatal.*

It is the object of the following experiment to find in what dilution KOH, NaOH, HCl and H_2SO_4 seedlings of Indian corn (*Zea Mais*) will be killed, and deduce facts concerning the toxic influence of H and OH ions upon these seedlings.

In order to be clearly understood in regard to terms used it might be well to give some quotations regarding them.

Gram-Molecule (Arrhenius, p. 9).—"Thus, for example, the molecular weight of HCl is 36.46, and consequently 1 gram-molecule of this (HCl) is 36.46 grams, that is, the equivalent weight in grams; a gram-molecule of sulfuric acid is 98 grams, *i. e.*, twice the gram equivalent."

Gram-equivalent (Arrhenius, p. 9).—"By a gram-equivalent of zinc we mean 32.7 grams of this metal; a gram-equivalent of a substance whose equivalent weight is E is E grams." Thus we see that a gram-equivalent of a monobasic substance is equal to its molecular weight, and of a dibasic substance is equal to one half its molecular weight.

Normal Solution (Sutton, p. 28).—"Normal solutions are prepared so that one liter of solution at 16° C. shall contain the hydrogen equivalent of the active reagent in grams (H = 1)." Fresenius (p. 687): "Solutions of such strength that 1,000 c.c. contains an amount of acid or base equivalent to one gram of hydrogen are normal solutions, *e. g.*

	Mol. wt.	Wt. in 1,000 c.c. of solution.
HCl	36.46	36.46
H_2SO_4	98.00	49.00
Na_2Co_3	106.08	53.04

The normal solutions used in this experiment were made according to the definitions of normal solutions by Sutton and Fresenius.

Tests in this experiment were made with each of four different dilutions of four different solutions, two of alkali, KOH and

* Kahlenberg and True, 'On toxic action of dissolved salts and their electrolytic dissociation,' *Bot. Gazette*, 22: 81, 1896.

† MacDougal's 'Text-Book of Plant Physiology,' 1901, p. 53, par. 78.

‡ Arrhenius, 'Text-Book of Electro-Chemistry,' p. 135.

§ 'Text-Book of Plant Physiology,' 1901, p. 53, par. 78.

* *L. c.*, p. 53, par. 78.

NaOH, and two of acid, HCl and H_2SO_4. The alkali solutions were $n/32$, $n/64$, $n/128$ and $n/256$. The acid solutions were $n/256$, $n/512$, $n/1{,}024$ and $n/2{,}048$.

The corn, which was chosen on account of its rapid growth and its straight main root, was soaked twenty-four hours, then put into a germinator containing sphagnum and allowed to remain forty-eight hours until the main roots were about 15 cm. long.

The tests were made in test glasses with a capacity of about 60 c.c. These glasses were thoroughly cleaned before using. Before the tests were made with the alkali the glasses were first washed with normal HCl, then with normal solution of the alkali used in the test, then they were washed and rinsed with water, then rinsed with distilled water, then with some of the solution used in the test. Before the tests were made with the acids the glasses were cleaned by the same process except that they were washed first with alkali solution then with acid solution.

The glasses were filled two thirds full of the solution to be used and labeled, then the seedling was taken from the germinator, carefully removing all the sphagnum; the grain was wrapped in dry cotton wool and fitted firmly in the top of the test glass, but not touching the solution, but the main root reached into the solution at least 10 cm. On the outside of the glass exactly opposite the tip of the root a dot was made with india ink, always holding the tip of the root in a line horizontal to the eye and sighting through the middle of the glass while marking.

The glass and seedling were then put into a dark chamber at a temperature of from 20° to 30° C. for twenty-four hours, after which the growth or elongation was measured. Then the seedling was removed, lightly washed with distilled water and put into a thoroughly cleaned glass with distilled water and allowed to remain in the dark chamber for another twenty-four hours, after which it was again measured.

The tests were started at 10 A.M. The four dilutions of one solution were carried on at the same time.

The results of the experiments were as follows:

TABLE I. SOLUTIONS OF KOH. BEGUN MAY 21, 10 A.M., CLOSED MAY 23, 10 A.M.

Concentration.	Growth in m/m.	Remarks.	Distilled.	Growth in m/m.	Remarks.
$n/32$	0	Flabby, dead.	H_2O	0	Flabby, dead.
$n/32$	0	Flabby, dead.	H_2O	0	Flabby, dead.
$n/64$	3	Yellowish. Probably only elongated.	H_2O	0	Root tip coagulated, dead.
$n/64$	1	Probably only elongated.	H_2O	0	Root tip coagulated, dead.
$n/128$	10	Natural appearance.	H_2O	15	Natural, alive.
$n/128$	7	Natural appearance.	H_2O	10	Natural, alive.
$n/256$	16	Natural appearance.	H_2O	19	Natural, alive.
$n/256$	17	Natural appearance.	H_2O	18	Natural, alive.
	54	Total growth.		62	Total growth.

We see by reference to the above table that there was a decided growth at $n/256$ and $n/128$ solutions, and when the seedlings were put into distilled water the growth was approximately the same. Thus it is evident that the elongation of the roots was due to actual growth.

In the tests with NaOH the results were similar to those of KOH, from which we might conclude that the toxic action of the two solutions is similar. However, the roots in NaOH $n/64$ had an appearance more nearly natural after each twenty-four hours than the roots in KOH of the same dilution; which suggests that the Na and K ions at this dilution might have some toxic influence and that of the K ions is greater than that of the Na ions.

TABLE II. SOLUTIONS OF NaOH. BEGUN MAY 26, 10 A.M., CLOSED MAY 28, 10 A.M.

Concentration.	Growth in m/m.	Remarks.	Distilled.	Growth in m/m.	Remarks.
$n/32$	0	Flabby.	H_2O	0	Flabby, dead.
$n/32$	0	Flabby.	H_2O	0	Flabby, dead.
$n/64$	1	Probably only elongated. Yellowish.	H_2O	0	Root appears natural except at the tip, dead, (?).
$n/64$	3	Yellowish.	H_2O	0	Root appears natural except at the tip, dead, (?).
$n/128$	12	Growth in a circle. Natural appearance.	H_2O	20	Natural, alive.
$n/128$	20	Natural appearance.	H_2O	30	Natural, alive.
$n/256$	11	Natural appearance.	H_2O	35	Natural, alive.
$n/256$	13	Natural appearance.	H_2O	20	Natural, alive.
	60	Total growth.		105	Total growth.

TABLE III. SOLUTIONS OF HCl. BEGUN JUNE 1, 10 A.M., CLOSED JUNE 3, 10 A.M.

Concentration.	Growth in m/m.	Remarks.	Distilled.	Growth in m/m.	Remarks.
$n/256$	2	Probably only elongated. Roots have pallid appearance.	H_2O	0	Coagulated, dead.
$n/256$	1	Roots have pallid appearance.	H_2O	0	Coagulated, dead.
$n/512$	18	Natural appearance.	H_2O	6	Natural, alive.
$n/512$	15	Natural appearance.	H_2O	21	Natural, alive.
$n/1024$	20	Natural appearance.	H_2O	36	Natural, alive.
$n/1024$	35	Natural appearance.	H_2O	30	Natural, alive.
$n/2048$	25	The root grew in a curve of 180°.	H_2O	20	Completed a circle.
$n/2048$	28	The root grew in a curve of more than 180°.	H_2O	25	Completed the circle then grew straight up.
	146	Total growth.		138	Total growth.

TABLE IV. SOLUTIONS OF H_2SO_4. BEGUN JUNE 4, 10 A.M., CLOSED JUNE 6, 10 A.M.

Concentration.	Growth in mm.	Remarks.	Distilled.	Growth in mm.	Remarks.
$n/256$	3	Natural appearance.	H_2O	0	Dead (?).
$n/256$	3	Natural appearance.	H_2O	0	Dead (?).
$n/512$	48	Natural appearance.	H_2O	40	Natural, alive.
$n/512$	35	Natural appearance.	H_2O	16	Natural, alive.
$n/1,024$	60	Natural appearance.	H_2O		Accident.
$n/1,024$	60	Natural appearance.	H_2O	50	Natural, alive.
$n/2,048$	50	Natural appearance.	H_2O	30	Natural, alive.
$n/2,048$	38	Natural appearance.	H_2O	16	Natural, alive.
	297	Total growth.		152	Total growth.

By comparing the total growth in H_2SO_4 with the total growth in HCl we see that the amount of growth in H_2SO_4 was over twice the total growth in HCl, but the difference in the total growth in H_2O after the seedlings were taken from the acid solutions was but small (20 mm.). This suggests that the ions in the HCl solutions produce a greater toxic effect upon the seedlings than those of H_2SO_4.

By comparison of the above tables we see that at the dilutions of the compounds used, the toxic effects of KOH and NaOH are practically the same, and the toxic effects of HCl and H_2SO are *approximately* the same.

In regard to the degree of dissociation of strong bases Arrhenius says:* "In the saponi-

* Arrhenius, 'Text-Book of Electro-Chemistry,' p. 184.

fication of bases it has been found that all strong bases exert about the same action. The velocity of reaction at 9°.4 is:

NaOH	2.31	$Sr(OH)_2$	2.20
KOH	2.30	$Ba(OH)_2$	2.14
$Ca(OH)_2$	2.29		

The numbers are for 1/40 normal solutions, in which the strong bases may be regarded as completely dissociated." As the dilution of the alkali at which death was produced was much greater the dissociation must have been complete, hence the death must have been caused by the OH and Na or K ions. And as the total growth of the seedlings in KOH solutions is nearly equal to the total growth in NaOH solutions, we can conclude that the toxic effect of Na ions is approximately equal to the toxic effect of K ions.

From a table of electrical conductivity* the degree of dissociation of HCl at $n/256$ was found to be 98.9, at $n/512$ it was found to be 99.5. The degree of dissociation of H_2SO_4 at $n/256$ was found to be 91, at $n/512$ it was found to be 95.6.

By comparing the dilutions at which the seedlings were found dead with the degree of dissociation given above it will be seen that there is quite a difference between the degrees of dissociation at the strength of the two solutions (HCl and H_2SO_4). While at the greatest dilution in which the seedlings lived in both solutions the difference is not so great. This difference in the degree of dissociation was manifest in the difference in the total growth of the seedlings in the different solutions; the solution less dissociated producing the greater total growth.

Thus we see that the corn seedling lived and grew in a $n/128$ solution of KOH and NaOH, and in $n/512$ solution of HCl and H_2SO_4. While Kahlenberg and True showed that a seedling of *Lupinus albus* L. just lived in $n/400$ solution of KOH and in $n/6{,}400$ solution of HCl. This shows that corn seedlings lived in a solution of KOH more than three times as strong, and in a solution of HCl more than twelve times as strong, as that in which the seedling of *Lupinus albus* just lived.

Although a seedling of a widely different species was used by Kahlenberg and True, yet it is remarkable that the corn seedling should resist the toxic effect of OH ions in a solution three times as concentrated, and that it should resist H ions in another solution twelve times as concentrated.

If the difference between the effects of the OH ions in one case is three times, why should we not expect the difference between the effects of the H ions in the other case to be about three times also? It seems logical to expect that the ratio between the effects of like solutions upon two different seedlings would be about the same in any solution.

It is my purpose to continue the investigation of this problem to find the exact dilution in which the seedling will just live; and how this death limit varies with different seedlings.

Fred A. Loew.

Agricultural College, Mich.,
June 16, 1903.

* Arrhenius, *l. c.*, p. 135.

THE SPONGY TISSUE OF STRASBURGER.

Many students of the gymnosperms have commented upon the peculiar structure of the cells immediately surrounding the female gametophyte during the period of its development. Both Hofmeister* and Strasburger† believed that two prothallia were formed in those members of the Abieteæ which require two years for the maturation of their seeds. They thought that the first or transitory prothallium was characterized by thickened cell-walls and that this cellular body was dissolved in the spring, giving place to the true or normal prothallium.

In 1879 Strasburger‡ established the fact of the existence of a single prothallium in the Abieteæ, and described a band of loosened

* Hofmeister, 'Vergleichende Untersuchungen höherer Kryptogamen und der Samenbildung der Coniferen,' 1851.

† Strasburger, 'Die Befruchtung bei den Coniferen,' 1869. 'Ueber Befruchtung und Zelltheilung,' 1878.

‡ Strasburger, 'Die Angiospermen und die Gymnospermen,' 1879.

cells or spongy tissue about the young gametophyte both in *Thuja* and in *Pinus*. He considered that it was the presence of this tissue which led Hofmeister to conclude that a transitory endosperm was formed in these plants. So far as one is able to learn from the literature, these early observations and conclusions of Strasburger's have remained unquestioned except by a few recent writers.

In describing the development of the ovule in Stangeria, Lang* (June, 1900) makes no mention of a spongy tissue, but says: "Around the megaspore a layer of cells was present which is clearly to be traced to the sporogenous group. The thick zone of sporogenous tissue present in earlier stages has, however, become reduced to a single layer. The cells of this persistent layer (Fig. 16) are very large, and stand with the longer axis at right angles to the surface of the megaspore. How long this layer of cells, which at this stage shows no signs of crushing or disintegration, persists, can not at present be determined; in the fertilized seeds all trace of it was gone. In the light of the present facts it would appear to be a probable conclusion that, while the majority of the sporogenous cells surrounding the embryo-sac simply become disintegrated and absorbed, the outermost form a more definite tapetal layer. This tapetum, while persisting longer than the more internal cells, ultimately disappears." The figure 16 to which Lang refers shows the persistence of this layer after the prothallium has become a multicellular body.

The manuscript of a paper by the writer† dealing with the development of the pollen tube in the pines had been in the hands of the publishers some weeks before Lang's paper appeared in America. It was not my purpose to give a detailed description of the development of the prothallium and related phenomena in that paper, inasmuch as this was to form the basis of a later paper now ready for publication; but incidentally the following statement was made: "The prothallium now consists of a uniform layer of protoplasm in which numerous free nuclei are embedded, no cell-walls as yet having been laid down. Immediately surrounding the endosperm, there is a definite band or hollow sphere of cells which is limited on its outer surface by a thin stratum of the disintegrating nucellus. These two layers constitute the so-called spongy tissue. The inner portion of this tissue, *i. e.,* the prominent band in immediate contact with the prothallium, must be intimately connected with the nutrition of the young endosperm. The true structure and function of this layer seem to have escaped the notice of previous writers. Its cells contain large nuclei, and are abundantly supplied with protoplasm. The karyokinetic figures so frequently observed in these cells show that this tissue increases in size by the growth and division of its cells as do the other portions of the ovule. As it enlarges, the cells of the nucellus in contact with its outer surface become disorganized and are absorbed (Fig. 3)." The figure referred to shows the prothallium and the disintegrating nucellar tissue separated by a definite zone of tissue two layers of cells in thickness. The cells of this band are conspicuous for their size and three of them show mitotic figures representing different stages of division. In Fig. 4 of the same paper this tissue is shown to be still present, but in a state of disorganization, at the time when the prothallium has become a solid multicellular body, and shortly before the division of the central cell.

Coker* finds that in *Podocarpus* "the macrospore arises deep in the nucellus and is not surrounded by spongy tissue such as is found in the Abieteæ, Cupresseæ, and Taxodieæ, and which has so often been erroneously described as of sporogenous character." To this statement he adds the remark: "Miss Ferguson's suggestion that the spongy tissue

* Lang, 'Studies in the Development and Morphology of Cycadean Sporangia.' II., 'The Ovule of *Stangeria paradoxa*.' *Ann. Bot.*, **14**: 281–306. 1900.

† Ferguson, 'The Development of the Pollen-Tube and the Division of the Generative Nucleus in Certain Species of Pines.' *Ann. Bot.*, **15**: 193–223. 1901.

* Coker, 'Notes on the Gametophytes and Embryo of *Podocarpus*.' *Bot. Gaz.*, **33**: 89–107. 1902.

is active in nourishing the prothallium is probably correct; an interpretation I had arrived at from a study of *Taxodium*."

I discussed somewhat in detail the structure and function of this tissue in a paper given before the Society for Plant Morphology and Physiology at its Washington meeting in 1903. In a brief summary of the paper* this sentence occurs: "The spongy tissue is not disintegrating tissue, as previously stated, but it forms a zone of physiological tissue which plays an important part in the nutrition and support of the developing gametophyte."

In a paper appearing in the current number of the *Botanical Gazette* (July, 1903), Coker† devotes three pages to a discussion of this tissue in *Taxodium*, designating it 'The large-celled tissue or tapetum.' His very clear description is accompanied by several figures representing this tissue at different periods in the development of the gametophyte. He finds that a definite band of large-celled tissue is early organized about the macrospore separating it from the disorganizing nucellar tissue. This large-celled layer continues until the prothallium has nearly or quite reached maturity. He ascribes to this tissue 'an active part in the nourishment of the young gametophyte,' and believes that it 'may be considered as a tapetum.' But he makes no reference at all to the application by Lang of the term tapetum to a similar tissue in *Stangeria*; neither does he in any way indicate that the active nature of this tissue has been noted by any other investigator. Furthermore, one can but be surprised to find such unqualified statements as: 'Moreover, this tissue in the Abieteæ is always spoken of as disorganizing'; and, 'I do not know of any case, however, where this tissue is said to persist in later stages.'

The tissue in contact with the outer surface of the gametophyte during its period of growth in *Taxodium*, as described and figured by Coker, is very similar to that occurring in *Pinus*. The various stages in the life history of the spongy tissue in *Pinus* are fully described and illustrated in a paper now in the process of publication, and I will not, therefore, repeat the details of its development here.

The presence of an active tissue about the growing prothallium in many gymnosperms is now an established fact, but our knowledge of the true nature of this tissue remains for the present more or less obscure. Lang (1900) speaks of it as both sporogenous and tapetal in nature. Coker (1903) suggests that it may 'represent an originally archesporial tissue which has given up its function of spore production and taken up the new rôle of nourishing the young plant within,' but he prefers to consider it a tapetum. It is not impossible that these cells are sporogenous in nature, each being a potential macrospore-mother-cell, but in a careful study of their origin and development I find no evidence that such is the case. If they represent the sporogenous tissue of some remote ancestor, they have beyond any question now lost their primitive function and have acquired a new and important function in connection with the development of the gametophyte. It is probable that this tissue not only passes on to the endosperm the nutritive substance derived from the nucellus, but that it is itself active in the manufacture of food, as Coker reports the presence of numerous starch grains within its cells in *Taxodium* and I have often observed them in *Pinus*. Furthermore, I believe that, in addition to its physiological rôle, this tissue serves an important mechanical purpose. It not only affords support for the prothallium during the long period in which it consists of a thin layer of cytoplasm containing free nuclei, but, gradually receding, it pushes before it, as it were, the tissue of the nucellus, thus making room for the growth of the delicate gametophyte.

There is certainly a very strong analogy between this tissue and a tapetum, but we are entirely in want of any evidence that the two are homologous structures. It does not, therefore, seem to me wise at present to apply to it the name tapetum, or to suggest a

* Ferguson, 'The Development of the Prothallium in *Pinus*.' *Science*, N. S., **17**: 458. March, 1903.

† Coker, 'On the Gametophytes and Embryo of *Taxodium*.' *Bot. Gaz.*, **34**. July, 1903.

new name by which to designate it. Strasburger's term 'spongy' tissue, although given when the nature of these cells was not understood, and being a misnomer so far as their structure and function are concerned, has obtained a wide usage in the literature of the gymnosperms and should be retained, just as the term cell is still retained in all biological literature.

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RECENT LITERATURE ON TRIASSIC ICHTHYOSAURIA.

WITHIN the past few months two important contributions have been made to our knowledge of the Triassic Ichthyosauria of the Eastern Hemisphere. The more extensive of these papers is one by Dr. E. Repossi,* giving the long-desired exact description and illustration of the material upon which Baur based the genus *Mixosaurus*. In this paper the statements of Baur concerning the primitive characters of this genus are strongly supported and many previously unknown and even unsuspected characters have been brought to light.

One of the most important contributions made by Repossi is the description of the pectoral and pelvic arches. These are quite unlike those of any Post-Triassic form of the order, but show a strong similarity to the corresponding structures in the Californian genus *Shastasaurus*. All of the elements excepting the ilium and clavicle are much broader and more robust than in *Ichthyosaurus*. The inter-clavicle is more nearly triangular than T-shaped and is hence more stegocephalian. The scapula, like that of *Shastasaurus*, has more of a mosasaurian than of an ichthyosaurian aspect.

Beautifully preserved specimens show the limbs to be pentadactyle with elongated epipodial bones and notched or sometimes shafted phalanges. A peculiar feature is found in the presence of four elements in the proximal row of the carpus and tarsus. Were it not for the character of the specialized mesopodial region, these limbs might well be considered as the primitive types from which the limbs of *Ichthyosaurus* were derived. The limb structure differs considerably from the types found in the Californian genera, both in the number of digits and in the character of the mesopodial region.

Another interesting discovery is the fact that the dorsal ribs of *Mixosaurus* are mainly single-headed. Those who have concerned themselves with this group seem generally to have taken for granted a double rib articulation.

A second paper of interest dealing with Triassic Ichthyosauria is one by N. Yakowlew on 'New Finds of Triassic Saurians in Spitzbergen.'* One of the specimens here described was found near the locality at which the type of Hulke's *Ichthyosaurus polaris* was discovered by Nordinskiöld, and as it resembles *I. polaris* in the size and general form of the vertebræ, it has been referred to this species. A posterior dorsal vertebra which has been figured is shown to differ from *Ichthyosaurus* in possessing a single broad apophysis for the articulation of the rib. This species is, therefore, placed by Yakowlew in the genus *Shastasaurus*. The vertebra is certainly very similar to some of the posterior dorsals of *Shastasaurus*. After a study of Hulke's descriptions and measurements of the type material, the writer has already expressed the opinion† that a careful examination would show it to belong in the Californian genus.

In this paper the valuable suggestion is made by Yakowlew that the ribs of the Ichthyosauria were primitively single-headed and that the double-headed form has been produced by more complicated and stronger movements of the ribs, causing disappearance of the middle portions of the rib heads and of the corresponding parts of the lateral apophyses

* 'Em. Repossi. Il Mixosauro degli strati triasici di Besano in Lombardia,' *Atti della soc. ital. di scien. natur.*, Vol. XLI., Fasc. 3, p. 361–372 tav. VIII., IX. Novemb., 1902.

* 'Neue Funde von Trias-Sauriern auf Spitzbergen,' *Verhand. der Kais. Russ. Mineralog. Ges.*, Bd. XL., S. 179–202.

† 'Triassic Ichthyopterygia of California and Nevada,' p. 88.

of the vertebræ. In a later article* written mainly in review of Repossi's paper on *Mixosaurus,* Yakowlew expresses the opinion that the double-headed character appeared first in the posterior portion of the dorsal region owing to the more vigorous movement of that portion of the body. It is difficult to reconcile this theory with the fact that in *Ichthyosaurus* the ribs tend to be single-headed toward the base of the tail and double-headed anterior to it, and that in *Shastasaurus,* which had also a great sculling tail, the ribs are all single-headed excepting a very few immediately behing the head.

Concerning Yakowlew's suggestion that the single-headed rib is the primitive type in this order, it is certainly a significant fact that it seems to occur frequently in the Triassic ichthyosaurs. We should not forget, however, that the oldest representative of the order which has been described, viz., Quenstedt's *atavus,* from the lower Muschelkalk, is said to have a double articulation and is possibly not to be referred to *Mixosaurus,* as has been generally supposed. Recent discoveries have shown the existence also in the Californian Triassic fauna of a form (*Toretocnemus*†), in which the middle dorsal ribs are as widely forked as in *Ichthyosaurus.* Again, it appears that in *Shastasaurus* the double articulation in the anterior part of the column is not formed by reduction of the middle portions of simple lateral apophyses. From the atlas to the anterior dorsal region the diapophyses are gradually increased in height and the parapophyses reduced till the latter are mere points some distance below the lower ends of the diapophyses. The lateral apophyses of the dorsal region, therefore, correspond to the diapophyses in the cervical region. If the double articulation in the neck region is secondary it would appear to have required the *addition* of a lower rib head and a parapophysis. There appears, therefore, to be still a chance that the double articulation is primitive in this group, and it may be well to withhold final judgment till we have a better acquaintance with the structure of the vertebral column as a whole in the later Triassic forms, and particularly till we know more about the Middle Triassic representatives of the group. JOHN C. MERRIAM.

* 'Einige Bemerkungen ueber die triassischen Ichthyosaurier.' *Verhand. der Kais. Russ. Mineralog. Ges.*, Bd. XL., Lief II.

† See *Bull. Geol. Dept. Univ. of Calif.*, Vol. 3, No. 12, p. 260.

NOTES ON PHYSICS.

INTERFERENCE OF LIGHT WITH GREAT PATH DIFFERENCE.

THE most carefully designed and constructed mechanical vibrator, such as a pendulum, cannot be made to vibrate, when left to itself, more than a few thousands of times without greatly decreasing in amplitude. On the other hand, the number of free oscillations made by an atom of a luminous gas during the intervals between collisions between that atom and others, during which times the atom is presumably not receiving energy from any source to make good its losses by radiation, is, in the case of mercury vapor at least, as many as 2,600,000 and that without very great decrease of amplitude. This follows from some recent work of Lummer and *Gehrcke,* who have recently shown that a given portion of the beam of light from mercury vapor (the green rays) is in condition to interfere with a portion of the same beam 125 centimeters or 2,600,000 wavelengths farther along the beam, which shows that as many as 2,600,000 successive waves come without a break of continuity from the vibrating luminous particles in mercury vapor.

THE ELECTROMAGNETIC THEORY OF MATTER.

The most complete and readable presentation hitherto made of the mathematical theory of the motion of minute electric charges (electrons) is given by Max Abraham in *Drude's Annalen* for January, 1903. It is by comparison of the results of this mathematical theory with results of experiments on cathode and Becquerel rays, on the Zeeman effects, etc., that the electromagnetic theory of matter has arisen.

An electrically charged body in motion has more momentum and stores more energy, in

other words it has apparently a greater inertia mass, than the same body without charge, and the electrical part of the mass is greater and greater the smaller the size of the body. The idea, which is fast gaining strength, that atoms are aggregates of extremely small charged particles, corpuscles as J. J. Thomson calls them, has given credit to the hypothesis that inertia is wholly electrical in character, inasmuch as an atom is known not to be small enough, assuming it to be homogeneous, to permit of its inertia being attributed wholly to its electric charge. The word *electron* seems to be most acceptable as a name for these ultimate corpuscles of disembodied electric charge.

The 'mass' of an electron is not fixed in value but it increases with velocity. In fact the very rapidly moving electrons (95 per cent. of the velocity of light) in Becquerel rays have greater mass than the more slowly moving ions in cathode rays, and measurements of mass and velocity of the electrons in cathrode rays and in Becquerel rays are in accord with the theoretical law of increase of mass with velocity. When an electron is accelerated in the direction of its motion its mass is different (longitudinal mass) from when it is accelerated at right angles to its direction of motion (transversal mass). The difference between longitudinal and transversal mass is sufficiently great numerically, when the velocity is great, to be an essential element in the established correspondence between theory and observation above mentioned.

The inertia or mass of the electron is purely electromagnetic in character; and if atoms and molecules are mere aggregates of electrons it follows that all mass and inertia are electromagnetic in character.

Some very curious laws of motion arise from the electron theory. When velocities and accelerations are very small Newton's laws of motion apply as very close approximations. When velocities or accelerations are large Newton's laws of motion fail utterly. One point of failure is the above-mentioned distinction between longitudinal and transverse mass—mass is not a scalar quantity but a so-called linear vector function; other curious points in the motion of electrons are the following:

Uniform motion in a straight line once established is steady or permanent. Uniform motion of an electron in a circular orbit, on the other hand, is accompanied by continuous radiation of energy, so that such motion must eventually cease if it is not maintained by some external agent. Thus two electrons rotating about each other after the manner of planet and satellite slowly radiate energy, and their motion is affected very much as if they were in a resisting medium. This motion of electrons as satellites is the fundamental hypothesis in the theory of the Zeeman effect.

A continuously accelerated electron stores an increasing amount of kinetic energy which can be regained by stopping the electron, and in addition it radiates energy continuously, which energy is lost. If the acceleration is very great this radiation may be considerable. Therefore, there is a drag upon the electron which is something like viscous friction but which depends upon *acceleration* and not on *velocity*.

An electron under way will, if quickly stopped and released, start up again of itself and move with diminished velocity in the original direction.

When an electron gains a certain velocity under the action of an accelerating force and the force suddenly ceases to act, then the electron loses some of its velocity and settles down to a slightly decreased uniform velocity.

An electron started quickly and kept moving at uniform speed must be acted upon, of course, by a great force to produce the quick start, and also by a lasting force which slowly drops to zero.

The kinetic energy of an electron is not proportional to the square of its velocity. This is another way of stating the fact which lies at the foundation of the variation of mass with velocity, and of the distinction between longitudinal and transverse mass. Thus, the only case in which an added velocity Y in the direction of the y-axis of reference means the same amount of work done whether

the moving particle has or has not already a velocity X in the direction of the x-axis, is the case in which the kinetic energy is simply dependent upon $X^2 + Y^2$.

Not directly connected with this matter of the dynamics of the electron, but of great interest, is the question of the amount of electrical energy stored in the electric field which surrounds an electron. Taking the data which have been obtained from experiments on cathode rays, it appears that a number of electrons sufficient to weigh a gram have associated with them about 6.10^{13} joules (or 40 million million foot-pounds) of energy when stationary. That is, estimating that a hot gas radiates 5 watts per gram, the total electron energy associated with an atom would last for a hundred *million million million* oscillations of full intensity before it were all exhausted by radiation, or rather the energy associated with a pair of rotating electrons would last for a hundred million million million periods before it were all radiated. This gives us some insight into the matter mentioned in the foregoing note on the interference of light with great path difference. It is probable that the limit of path difference which will produce interference is determined by frequency of molecular collisions rather than by diminished amplitude of atomic oscillations between collisions.

Another matter of interest, growing out of the excessively small size of the electron, vastly smaller than the atom, is that the electrons are always at great distances apart in comparison with their size, so that the variations of total energy due to different forms of electron aggregation are but a small fraction of the total energy. Thus the diminution of energy accompanying the formation of a gram of water is only about 16,000 joules or one four-thousand-millionth part of the total electron energy.

Another matter of interest is that the volume integral of ether stress—which may be the fundamental cause of gravitation—is independent of states of electron aggregation to about the same degree of approximation as above pointed out for electron energy.

W. S. F.

CURRENT NOTES ON METEOROLOGY.

MARCH WEATHER PROVERBS.

MR. B. C. WEBBER, acting director of the Meteorological Service of Canada, contributes a paper on 'March Winds' to a recent number of the *Monthly Weather Review* (Vol. XXXI., No. 3). On the basis of thirty years' records for Ontario, Quebec and the Maritime Provinces, it appears that there is a considerable decrease in the number of days with high winds in March, as compared with the three preceding months; that the month of March has fewer cold winds than February; that the snowfall of March is very much less than during the preceding winter months, and that there is nothing in the records for the past thirty years to justify the assumption that 'if March comes in like a lion it goes out like a lamb.' Thus do many of the 'popular' sayings about the weather often prove to be without foundation in fact when they are confronted with the results of meteorological observations. The results of the investigation along somewhat similar lines, by W. B. Stockman, of the U. S. Weather Bureau, are discussed in the May *Review*.

HEIGHT OF THE SEA BREEZE.

OBSERVATIONS as to the height of the diurnal sea breeze are few in number, albeit of considerable importance. By means of a captive balloon, sent up from Coney Island a number of years ago, it was found that the average height at which the cool inflow from the ocean was replaced by the upper warm outflow from the land was from 500 to 600 feet. At Toulon, in 1893, the height of the sea breeze was found to be about 1,300 feet, and a distinct off-shore current was found between 1,900 and 2,000 feet. More recently (1902), on the west coast of Scotland, Dines, using kites, has noted that the kites would not rise above 1,500 feet on sunny afternoons, when the on-shore breeze was blowing (*Quart. Journ. Roy. Met. Soc.*, April, 1903).

STORMS OF THE GREAT LAKES.

FOR some years the Weather Bureau has been giving special attention to the storms which occur over the Great Lakes, with a view

to making navigation on the lakes safer. Bulletin K of the Weather Bureau, by Professor E. B. Garriott, entitled 'Storms of the Great Lakes' (4to, 1903, pp. 9, charts 968), includes 768 charts illustrating the more important storms of the lakes which have been described in the *Monthly Weather Review* during the twenty-five-year period 1876–1900. Each storm is illustrated by four charts, covering thirty-two to forty-eight hours of its history, the object being to present typical lake storms which have occurred in the different months of sufficient intensity to be dangerous to shipping. The month of November, with forty-five severe storms in twenty-five years, stands first. October and December rank in the same group, and then come September and March. The storms are classified as 'southwest storms (the most destructive)'; 'storms from the middle west,' 'northwest storms,' and 'storms of tropical origin.' This *Bulletin* will be useful first of all to the forecasters of the Weather Bureau whose districts embrace part of the Great Lake region, and to navigators on those Lakes, but teachers of meteorology in schools and colleges will find in this very large number of selected charts abundant material for illustration in connection with the study of weather maps and of cyclones.

NOTES.

The Annuaire météorologique pour 1903, of the Royal Observatory of Belgium, contains, in addition to the usual meteorological data and tables, the following special contributions: A. Lancaster, 'La Force du Vent en Belgique' (pp. 220–352); E. Vanderlinden, 'Étude sur la Marche des Cirrus dans les Cyclones et les Anticyclones d'après les Observations faites à Uccle'; J. Vincent, 'Aperçu de l'Histoire de la Météorologie en Belgique, III. Partie.'

Beginning with May 6 last, the meteorological records obtained by means of kites at Hamburg have, together with those obtained at the Berlin Aeronautical Observatory, been published in the daily weather reports of the German Seewarte.

R. DeC. Ward.

BOTANICAL NOTES.

RECENT BOTANICAL PAPERS.

Among the recent botanical papers may be mentioned the following:

'The Wood Lot,' by Professor H. S. Graves, of the Yale Forest School, and R. T. Fisher, of the United States Bureau of Forestry. It is published by the United States Bureau of Forestry, and discusses the woodland problems, especially in New England, and makes suggestions in regard to the use and perpetuation of the small bodies of woodland which still persist in that portion of the country. It should prove very valuable to the New England farmer.

'The Seasoning of Timber,' is an interesting paper by Doctor von Schrenk, of the United States Bureau of Forestry. In it he discusses the problems which face the practical man in the seasoning of timber. The distribution of water in the timber, its relation to decay, what seasoning is, something as to preservative treatments, etc., make up the first part of the book, and this is followed by a discussion of experiments made in the west in the endeavor to secure greater durability by treatment of one kind and another. The paper is certainly one of the most helpful of any published by the bureau.

Mr. J. N. Rose, of the United States National Museum, publishes in the Contributions from the United States National Museum, a continuation of his 'Studies of Mexican and Central American Plants.' This contribution covers nearly sixty pages, and is filled with descriptions of new and little-known plants from this very interesting region. Several good colored illustrations accompany the paper.

In a recent number of *Rhodora*, Professor C. S. Sargent continues his descriptions of 'Recently Recognized Species of Crataegus in Eastern Canada and New England.' He adds a number of new species to the already very long list of recently separated forms.

ANOTHER PHYTOBEZOAR.

Some time ago there came into my possession a ball about ten centimeters in diameter,

which was taken from the stomach of a hog in October, 1899. This was one of several similar balls. When it came into my possession it had been somewhat compressed, so that it was somewhat cuboidal in form. Evidently, however, its form originally was pretty nearly spherical. From a preliminary study of the substance of the ball, I find that it consists entirely of vegetable fibers, and as far as the examination has gone these fibers appear to be those of alfalfa (*Medicago sativa*).

Externally, the ball is grayish in color with darker brown spots over the surface. The interior is buff color, and the whole is quite hard. It resembles in a general way the hair balls which are so frequently found in the stomachs of cattle, but is considerably heavier. This preliminary notice is made in order to call the attention of botanists who are situated near packing-houses where swine are killed to the possibility of finding more of these curious formations. A careful examination will be made of the fibrous material composing the ball, and a full report then published. Photographs have been taken of the ball, and these will be reproduced when the investigation has been completed.

CHARLES E. BESSEY.
UNIVERSITY OF NEBRASKA.

MEMORIAL OF THE LATE WALTER REED.

ON the fifteenth of August a meeting was held in Bar Harbor of friends of the late Major Reed, M.D., U.S.A., to whom in a large degree is due both the discovery of the mode by which yellow fever has been spread, and also the consequent suppression of that dire disease. Representative men were present from different parts of the country and letters were received from various members of committees already appointed to promote the collection of a memorial fund in grateful commemoration of Dr. Reed's services. Important suggestions were presented from President Eliot, Dr. W. W. Keen, Professor J. W. Mallet and others. Dr. Daniel C. Gilman, chairman of a committee appointed by the American Association for the Advancement of Science, presided, and Dr. Stuart Paton acted as secretary. Among those who took part in the conference were Dr. W. H. Welch, of Baltimore; Dr. Janeway, of New York; Dr. Abbott, of Philadelphia; Dr. Herter, of New York; Dr. Barker, of Chicago; Dr. Putnam, of Buffalo; Dr. Fremont Smith, of Bar Harbor; and Dr. Sajous, of Philadelphia; and besides these medical gentlemen, Bishop Lawrence, of Massachusetts, and Messrs. Morris K. Jesup, president of the New York Chamber of Commerce; John S. Kennedy, president of the Presbyterian Hospital of New York, and William J. Schieffelin, of New York. The following conclusions were reached: that an effort should be made to raise a memorial fund of $25,000 or more, the income to be given to the widow and daughter of Dr. Reed, and after their decease the principal to be appropriated either to the promotion of researches in Dr. Reed's special field, or to the erection of a memorial in his honor at Washington. Arrangements were made for the publication of circulars explaining this movement, and asking cooperation not only from the medical profession, but from all liberally disposed individuals who appreciate the value of Dr. Reed's services to mankind.

SCIENTIFIC NOTES AND NEWS.

THE American Chemical Society will hold its next meeting in Convocation Week in conjunction with the meeting of the American Association for the Advancement of Science.

DR. EMIL TIETZE, director of the Imperial Geological Institute of Austria, was chosen president of the Ninth International Geological Congress, which opened at Vienna on August 20.

DR. E. VON LEYDEN, professor of pathology at the University of Berlin, celebrated the fiftieth anniversary of his doctorate on August 11.

DR. R. LYDEKKER, F.R.S., has been elected a foreign member of the Accademia dei Lincei of Rome.

The Botanical Gazette states that Mr. C. G. Lloyd, of Cincinnati, has been elected a member of the German Botanical Society and of the Botanical Society of France.

Mr. Charles J. Brand has been appointed to an assistant curatorship in the Department of Botany of the Field Columbian Museum.

Dr. Nicolas Leon, archeologist and ethnologist of the National Museum of Mexico, has returned to the City of Mexico after a visit to the state of Coahuila, where important excavations are being conducted.

The daily papers state that Dr. Nathan A. Cobb, pathologist of the department of agriculture of New South Wales, has declined the position of chief of the Philippine Agricultural Bureau, giving as his reason his intention of shortly returning to the United States.

We learn from the *Botanical Gazette* that Homer H. Foster, professor of botany in the University of Washington, has resigned in order to take up commercial work in connection with a hardwood lumber firm in Chicago.

Nature states that Mr. A. S. le Souef has been appointed director of the Zoological Garden at Sydney in succession to the late Mr. Catlett. Mr. Dudley le Souef, his elder brother, has been director of the Zoological and Acclimatization Society at Melbourne for several years, and a younger brother is director of the newly established garden at Perth, in Western Australia.

The Commission of Inquiry into the educational systems of the United States in their bearing upon commerce and industry, projected last year by Mr. Alfred Mosely, C.M.G., but postponed owing to the unsettlement over the education bill, will start from Southampton on October 3, Mr. Mosely himself preceding it by two or three weeks to make arrangements for its reception. The commission consists of about thirty members including Professor W. E. Ayrton, Professor Magnus Maclean and Dr. W. H. Gaskell.

Dr. Gustav Steinmann, professor of geology at Freiburg, accompanied by Baron Bistram and Dr. Hoek, have started on an expedition to the Bolivian Andes.

It is stated in *Nature* that for the study of bird migration, Mr. W. Eagle Clarke, assistant keeper in the Natural History Department of the Edinburgh Museum of Science and Art, has obtained permission from the Elder Brethren of Trinity House to spend a month upon the Kentish Knock Lightship, situated off the mouth of the Thames, and about twenty-one miles from the nearest point of land. The position of the vessel affords exceptional opportunities for observing the east and west autumnal movements of birds across the southern waters of the North Sea.

Dr. Martin Kellogg, president of the University of California from 1890 to 1899 and previously professor of Latin, has died at the age of seventy-five years.

Dr. Frederick Law Olmsted, the eminent landscape architect, has died at the age of eighty-one years.

The death is announced of M. Meunier Chalmers, the French geologist and paleontologist, professor at the Sorbonne.

News has recently been received of the death, in Paraguay, of Signor Guido Boggiana, a young Italian explorer and man of science. He was murdered by the Chamacoco Indians, and his notes and photographs were destroyed.

There will be a civil service examination on October 21 and 22 to fill fourteen vacancies in the position of civil engineer in the Philippine service with salaries ranging from $1,400 to $1,800 a year.

The French Association for the Advancement of Science held its annual meeting at Angers last month under the presidency of M. Emil Levasseur, the eminent economist.

The International Geodetic Association met from August 4 to 14 under the presidency of General Bassot, of the Institute of France.

M. Roux has given the Osiris prize of $20,000, and M. Metchnikoff a prize of $1,000 that he has recently received, to the Pasteur Institute, to be used for their experiments.

Pietro Cartoni has given $200,000 to found a sanatorium for tuberculous patients at Rome, in memory of his two sons, who died of tuberculosis.

A national sanitary congress is to be held at Milan in 1905, on the occasion of the exhibition which we have already mentioned. The work of the congress will be divided

among the following sections: sanitary assistance; public hygiene; clinico-scientific and therapeutic; medical jurisprudence and accidents to workmen; professional interests.

At the instance of the German minister of commerce several high mining officials will shortly be sent to England to make a thorough study of the hygienic and sanitary arrangements in mining districts.

According to *Terrestrial Magnetism* the Dutch government has granted the means for a new magnetic survey of the Dutch archipelago during the years 1904–1907. During each of these years the field work is to cover two to four months, only a general survey being possible with the present means. A beginning has already been made, observations having been made on the 'tin island,' Billiton, and at some points in the neighborhood of Batavia, and it is also hoped to secure values at different stations in Java partly to obtain early information regarding the secular variation.

A daily medical journal, edited by Dr. M. W. Curran, is announced for publication, beginning in October.

Major Penton, principal medical officer of the Soudan, has written a letter to Major Ronald Ross, which the latter communicates to the London *Times*. Major Penton writes: As the prevention of malarial fever is of the utmost importance to us in the Soudan, I have recently paid two visits to Ismailia to study on the spot the measures which, on your recommendation, are now being enforced for the destruction of mosquitoes. The results have been remarkably successful. The town is practically free from mosquitoes, which only a short time ago were very abundant. Mosquito-nets can almost be dispensed with, for one can now sleep without being bitten, as I found from personal experience. The operations you recommended are in full swing. Two marshy swamps to the northeast of the town have been filled up with sand, and a third, the largest, will shortly be dealt with. It will be drained by a pipe twenty-two centimeters in diameter, to convey away the water. Other marshes to the south of the town have been filled up. At my last visit I saw a gang of 180 workmen busily employed in filling up pools, mowing the coarse grass and undergrowth and clearing the numerous small channels or branches in connection with the main canal. The foreman of works informed me that when the men first commenced operations they were much worried with swarms of mosquitoes towards evening, but that now they scarcely saw any. Coincident with the destruction of mosquitoes and other larvæ, malarial fever at Ismailia this year shows a most striking improvement. All medical officers employed there are agreed upon this. Statistics show that up to the present it is the healthiest year on record. Dr. Pressat informed me that from January 1 to June 30 of this year there were only three cases of malarial fever in hospital, against 52 for the same period last year, and that throughout Ismailia there were 569 cases of fever from January 1 to May 30, 1902 (an average year), against 72 for the same period this year. It is more than probable, moreover, that many of the cases were relapses from previous infection. Bearing in view the remarkable diminution in malarial fevers that has attended the present operations against mosquitoes, it is more than probable that when they are completed, malarial fevers will have practically disappeared.

In his report to the United States Geological Survey on the production of petroleum in 1902, now in press, Mr. F. H. Oliphant notes the following points as the most conspicuous features in the production, sale and export of crude petroleum and its products for the year 1902: The production of crude petroleum was greater than that of any previous year; there was a slight decrease in production of the Appalachian field, and a slight increase in the Lima-Indiana field; the general average price for crude petroleum was less than in any year since 1898; stocks held in the Appalachian and Lima-Indiana fields showed a considerable decrease, principally in the Appalachian field; the exports of petroleum in 1902 were less than in 1901; no new pools were discovered in 1902. The total production in the United

States of crude petroleum in 1902 was 80,894,590 barrels, as against 69,389,194 barrels in 1901, an increase of 11,505,396 barrels, or 16.5 per cent. over that of 1901, and of 27 per cent. over that of 1900. The greatest portion of the increase in 1902 came from Texas and California, the gain being 5,830,994 barrels, or 132.7 per cent. for Texas, and 5,187,518 barrels, or 59 per cent., for California, as compared with their respective productions in 1901. The increase in Indiana in 1902 was 1,723,810 barrels, or about 30 per cent. over that of 1901. Louisiana produced for the first time in 1902, the production being 548,617 barrels. The increase in the production of Kansas was 152,598 barrels, or about 85 per cent. over 1901. Kentucky and Tennessee increased their production in 1902 by 47,799 barrels, or nearly 35 per cent. Indian Territory increased 27,000 barrels and Wyoming 850 barrels as compared with 1901. The largest decrease in production in 1902 as compared with 1901 was in West Virginia, where it amounted to 663,781 barrels, or about 4.5 per cent.; and Ohio, in its two fields, showed a decrease of 633,852 barrels, or nearly 3 per cent. The decrease in Pennsylvania was 561,498 barrels, or 4.5 per cent.; in New York, 86,888 barrels, or about 7 per cent.; in Colorado, 66,218 barrels, or about 14 per cent. The percentage of production by fields shows a remarkable change from 1900 to 1902. In 1900 the percentages were: Appalachian field, 57; Lima-Indiana field, 34; all other fields, nearly 9. In 1902 the respective percentages were: Appalachian field, 39; Lima-Indiana field, 29; all other fields, about 32. The value of the crude petroleum produced in 1902 was $69,610,384, or 86 cents per barrel, that for 1901 having been $66,417,335, or 95.7 cents per barrel, a decrease of 9.7 cents per barrel, or 10 per cent., in 1902. The gross amount received for the total product in 1902 was only $3,193,013 greater than that in 1901, although the increase in output was about 16.5 per cent. greater.

A CORRESPONDENT writes to the London *Times* that the monthly general meeting of the Zoological Society, held on August 20, was of considerable importance, inasmuch as it settled future practice in matters about which there had been some doubt—the appointment by the council of members of their own body to official posts, and their engagement for special work, partly literary and partly scientific in its character. When the reorganization committee submitted its recommendations to a general meeting at the end of last year it was resolved to ask Mr. de Winton to undertake the post of superintendent, vacant through the resignation of the late Mr. Clarence Bartlett on account of ill-health, and to carry out the reorganization of the gardens. That gentleman accepted the charge, and since his appointment had done a good deal, not only in improving the gardens, but in cutting down expenses. The council found that the time allotted was too short to allow of his carrying out what had been planned, and, on being invited, he consented to accept the post for a second year. But, acting under legal advice, the council felt bound to submit the matter, with some others, to the decision of a general meeting. Dr. Guenther, who presided, accordingly put an official motion, of which due notice had been given, to the effect that the appointment should continue during 1904 with emoluments at the rate of £400 a year and an official residence in the gardens. The chairman spoke warmly in favor of the motion, as did Dr. Henry Woodward, Mr. Oldfield Thomas and Mr. Bowes. Major Cotton did not oppose the motion, but urged the desirablity of seeking a candidate outside the ranks of the council, and Professor Cunningham was of opinion that it would be desirable to have a decision as to whether members of council should be eligible for paid posts. The chairman admitted that the appointment was only a temporary one, made at a critical period in the history of the society. On being put from the chair, the motion was carried unanimously. Other motions dealt with payments for work done by two members of council—Dr. Sharp, as editor and recorder, and Mr. Boulanger, as recorder, for the *Zoological Record*, which gives titles and brief abstracts of zoological literature all over the world, and is published by the society

yearly. Dr. Henry Woodward and Mr. Oldfield Thomas explained the nature of the work, which can only be done by men of considerable scientific attainments and linguistic skill. Professor Cunningham suggested that the appointment of recorders in the different subjects should rest with the editor, and not with the council, to which the reply was that, as the editor was paid a merely nominal sum for his services, it would be unfair to impose this additional labor on him. The motion was carried without a dissentient, and the meeting adjourned to November 19.

The Geographical Journal states that a preliminary report has been received from the leader of the second expedition sent out to Brazil by the Royal Academy of Sciences of Vienna. After landing at Pernambuco, two excursions were made by rail to the neighborhood of Berberibe and Pas d'Alho, which gave a foretaste of the enormous wealth of bird-life in those tropical regions. A similar impression was made by excursions round Bahia, to Cabula, Rio Vermelho, the neighborhood of Barra near the Bahia lighthouse, and even on the outermost slopes, covered with vegetation, between the east of the town and the sea. Here was first seen the *Wistiti* (*Hapale Jacchus*), which is peculiar to Bahia and Pernambuco. On the journey to the Rio Sao Francisco extensive ornithological collections were made; a week was spent at Joazeiro, on the right bank of the great river. An imposing representative of the bird world here is the Nandu, or Ema (*Rhea macrorhyncha*). The characteristic mammals of this region are the armadillo (*Dasypus*), pouched rat and anteater. Fish are abundant in the river, but there are not many species. The Pirá (*Conarhynchus conirastris*), with a long curved tube-shaped snout, and Pacrí (*Myletes*), with a shark's mouth, are remarkable, being of larger size than most of the others. Hofrath Steindachner expects a particularly rich yield of fishes characteristic of the region from the stay at Barra, where the Rio Grande flows into the Sao Francisco. Lacertilians are represented in the neighborhood of Joazeiro by eight or nine species, including a very delicate dark-striped Scincoid with a blood-red tail. Most of the small variegated or dark-colored snakes of this region are said to be poisonous. The Ema mentioned above is greatly valued as a destroyer of snakes, and is kept on the haciendas. The kites do their utmost in destroying animal 'undesirables,' and enjoy the greatest favor all over the country. The whole bird-life of the Joazeiro district resembles that of the Amazon region more closely than that of southern Brazil. In the middle of March the desolate solitudes of the bush were explored, starting from the railway at Carnahyba, and a nearly complete collection of the birds, consisting of some fifty specimens, was made. The most characteristic representatives are five species of pigeons and two of parrots.

UNIVERSITY AND EDUCATIONAL NEWS.

Mrs. Cyrus H. McCormick and her three sons, of Chicago, have given $10,000 to Washington and Lee University, the interest of which is to be devoted to the development of the department of physics. A new laboratory of engineering and physics, the gift of another friend in Chicago, whose name is for the present withheld, is expected to be ready for occupation next summer.

Dr. Johann Hjort and others offer courses of instruction on marine investigations at Bergen during the months of September, October and November. There is no charge for the courses which include lectures, laboratory work and field work.

Mr. C. F. Baker has been appointed assistant professor of biology in Pomona College, Claremont, Cal.

Dr. O. Schmidt and Dr. Julius Meyer have qualified as docents in chemistry in the universities of Bonn and Breslau, and Dr. R. Gans and Dr. Kohl as docents in physics in the universities of Tübingen and Vienna, respectively.

Dr. R. Brauns, professor of mineralogy at Giessen, has been elected rector for the coming year.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 11, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE SOUTHPORT MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

IT is just twenty years since the British Association first met at Southport, a comparatively short interval between two successive visits of this peripatetic body to one place. Although Southport in 1883 was a much smaller place than it is now, it was yet able to accommodate in addition to its crowd of summer visitors 2,710 members and associates of the British Association. Since then Southport has considerably extended its bounds and greatly increased its accommodation for holiday-makers, so that if the attendance at the meeting which begins on September 9 be increased in proportion, the second Southport meeting ought to reach the *maximum*. The previous one was above the average, and after all, it is doubtful whether it will be much exceeded on the present occasion. And yet Southport itself has many more summer attractions than the great cities which form the usual places of meeting of the association. Its fine sands, its esplanade and its numerous other open-air attractions may tend, should the weather be favorable, to diminish the attendance at the sectional meetings, especially among that considerable body who, without disrespect, may be called the camp followers

* From the London *Times*.

of the army of science—a section which at the same time performs a most useful function, as without such a body the receipts at the previous meeting would not have amounted to the considerable sum of £3,369, enabling the association to allot grants for scientific investigation amounting to £1,083. What may be called the outside attractions of the second Southport meeting will be many. The local committee have exerted themselves to the utmost to make the meeting in this respect a thorough success, and it is to be hoped that the meteorologists, who are to have a special conference in connection with the meeting, will take measures to provide the kind of weather which they may be sure their hosts are praying for.

The scientific attractions of the neighborhood will be fully dealt with in the handbook which is in preparation. Ample provision has been made for the usual entertainments in the way of receptions and excursions. A reception by the mayor of Southport in the municipal buildings is announced for Thursday evening, September 10, and on the following afternoon there will be a garden party, also given by the mayor, in Hesketh Park. Saturday will, as usual, be a free day so far as the work of the sections is concerned. Arrangements have been made for a number of excursions to places of interest in the surrounding country, including Windermere, and also for visits to Chester and Manchester. This last should prove especially attractive to members who wish to combine solid instruction with their pleasure, as those taking part in the excursion will be conducted over the works of the British Westinghouse Electrical and Manufacturing company. The company has kindly promised to provide luncheon for the visitors, and opportunity will be afforded to the party of viewing the new technical school, the John Rylands Library and the Chetham Hospital. On either Monday or Tuesday a garden party will be given by Sir George Pilkington, who is this year one of the vice-presidents of the meeting, and on the evening of the latter day the local committee has arranged to entertain the association at a *conversazione* in the municipal buildings. Interest in the sectional meetings has, it is to be feared, generally begun to wane by the concluding day of the gathering, and accordingly there have been arranged for the afternoon of Wednesday certain excursions which, though unofficial, will probably attract a good many of the members. These are to Messrs. Lever's well-known model village, Port Sunlight, the Diamond Match Works at Seaforth, and the Cunard steamship *Lucania*. Members will also be given on the following day the opportunity of visiting various industrial enterprises of interest, including works for the manufacture of watches, a Lancashire industry which, after falling on evil days, has been revived with a considerable measure of success.

The accommodation for the sectional work of the meeting seems to be ample. The opening meeting on the evening of September 9, when the president, Sir Norman Lockyer, will deliver his inaugural address, will be held in the opera house, while the three evening lectures will be delivered in the Cambridge-hall. The first of these, on Friday evening, will be by Dr. Robert Munroe, on 'Man as an Artist and Sportsman in the Paleolithic Period.' The Monday evening discourse will be by Dr. Arthur Rowe, on 'The Old Chalk Sea and some of its Teachings,' while the lecture to working men on Saturday evening will be by Dr. J. S. Flett, who will give an account of his observations on the recent volcanic eruptions in the West Indies.

One of the most noteworthy features in connection with the first Southport meeting was the inaugural address of its president, the late Professor Cayley. Professor Cayley was one of the most profound mathematicians that ever lived. He was so absorbed in his subject that even on such an occasion he could not wrench himself outside its limits. It was a masterly discourse, dealing with exceedingly abstruse problems in the highest mathematics, and was probably not fully understood by a score of those to whom it was audible. Sir Norman Lockyer is, like his predecessor at Southport, also a specialist, but a specialist in more than one department. His career as a scientific worker has been associated for considerably more than half a century with the spectroscopical observation of the heavenly bodies and related subjects, with brilliant results both in the way of actual discoveries and of hypotheses. Sir Norman Lockyer has for an equally long period devoted his energies to what we may venture to call another speciality, the endowment of research, which he has done much to promote, and it is probably with one department of the latter subject that he will deal in his presidential address at Southport. He will insist, we believe, on the paramount influence of science and scientific research on national progress, and will endeavor to show at some length how largely our national salvation depends on the adequate endowment of our universities. Sir Norman Lockyer's address is sure to be both emphatic and brilliant.

So far as the ordinary work of the various sections is concerned, to judge from the particulars with which the sectional presidents and recorders have kindly favored us, it promises to be quite up to the average, both in quality and quantity. While, as a whole, it will be conducted on the usual lines, and while much of it will appeal only to specialists, in certain of the sections subjects of wide interest will be discussed.

The president of Section A (mathematical and physical science) will be Mr. C. V. Boys, one of the most brilliant, original and unconventional of our younger physicists. No particulars are yet available as to the subject of the address which he proposes to deliver, but his discourse is certain to be interesting and worthy of the occasion. As the International Meteorological Congress, under the presidency of Professor Mascart of Paris, is meeting at Southport at the same time as the British Association, the department of Section A devoted to meteorology and astronomy will this year be particularly strong in meteorological papers. Contributions have been promised by several of the distinguished foreign members of the congress, including Hildebrandson, Paulsen and Panta; and Dr. W. Lockyer will give an account of his researches on simultaneous solar and terrestrial phenomena. The physical portion of the section will be occupied mainly in discussing three questions of importance at the present moment—namely, the nature of the emanations from radio-active substances, the method of dealing with non-reversible processes in the general theory of heat and the use of vectorial methods in physical work. Professor Rutherford, of Montreal, will open the first with an account of the experiments which have led him to the conclusion that the emanations from radium are material; Mr. Swinburne will open the second and the third will be introduced by Professor Henrici. It is hoped that it will be possible at the meeting to come to definite conclusions on these three questions.

Professor W. Noel Hartley will preside over Section B (chemistry). He proposes,

in his presidential address, to give a brief account of twenty-five years' work in spectroscopy, applied to the investigation of the composition and constitution of terrestrial matter, both organic and inorganic. He will review the present position of spectroscopical investigation, chiefly in relation to the theory of chemistry, indicating where it may be usefully and profitably extended. The trend of such work at the present time is towards results of a very interesting character. As regards the general work of the section, the number of papers sent in is considerable, and they deal with a great variety of subjects. A paper on 'Dynamic Isomerism,' by Dr. T. M. Lowry, will be one of the reports which have during recent years been a feature of the proceedings of the section. It will consist of a *résumé* of the whole subject of the dynamic isomerism or tautomerism, which has lately attracted much attention, and a fruitful discussion should follow. Dr. A. W. Crossley will contribute a paper on 'Hydro-aromatic Compounds' forming a supplement to the valuable report which he presented at the Belfast meeting last year. It will give the results of the recent investigations undertaken by Dr. Crossley and others on the turpentines, camphors and other hydro-aromatic substances. A paper by Professor W. J. Pope (recorder) and Mr. J. Hübner will show that the luster produced on cotton yarn by merurigation—or steeping, whilst under tension, in caustic soda—is due to a simultaneous shrinkage, swelling and untwisting of the fiber whilst in a gelatinous state. An interesting accompaniment of this paper will be a series of photo-micrographs taken in natural colors. A discussion on the general subject of combustion will be opened by Dr. W. A. Bone with a paper on 'The Combustion of Methane and Ethane,' whilst a somewhat unusual feature in the program will be papers in French by Count Arnaud de Gramont, entitled 'Sur le Spectre du Silicium' and 'Sur les Procédés de Photographie Spectrale Applicable à la Pratique des Laboratories de Chimie.' These are but a few items in the program, other contributions including papers on 'Fluorescence,' as related to the constitution of organic substances, by Dr. J. T. Hewitt; 'Essential Oils,' by Dr. O. Silberrad; 'The Action of Diastase on the Starch Granules of Raw and Malted Barley' and 'The Action of Malt Diastase on Potato Starch,' by Mr. A. R. Ling and Mr. B. F. Davis; a contribution to the 'Constitution of the Disaccharides,' by Professor Purdie and Dr. J. C. Irvine and a 'Method of Separating Cobalt and Nickel and the Volumetric Determination of Cobalt,' by Mr. R. L. Taylor. Altogether there is every reason to hope that Section B will this year have a more prosperous meeting than it had last.

The main aim of Professor W. W. Watts, secretary of the Geological Society, in his presidential address to Section C (geology), will be to show the importance and uses of geology in practical life. He will advocate its adoption as a subject of ordinary education, because, in the first place, its study both exercises the observing faculties and encourages the making of hypotheses for the testing and verifying of which there is ample material. Moreover, its pursuit leads to an open-air life in contrast to the confinement in laboratories and museums imposed on the students of other branches of science; for the aim of all geological teaching should be the making of the field geologist; even specialists in paleontology and petrology should be field men as well. Then, again, he will contend that a knowledge of some of the main facts established by geology, such as the extension of time, the antiquity of

man and the evolution of climate and geography, ought fairly to be regarded as part of the stock in trade of the man of average education. Passing to the practical uses of such training and knowledge, he will point out, first, how the eye is trained to appreciate a country and the use of this in reading and mapping topographical features; secondly, the use of the conclusions of geology as a foundation for geographical knowledge; and, thirdly, the importance of geological knowledge in connection with all economic questions relating to mineral wealth. Unfortunately for Section C, the Southport meeting clashes with the International Geological Congress at Vienna, at which several of the leading British geologists are to be present. A number of papers have been arranged for, however, and though none appears to be of very outstanding importance, a fairly full program may be expected. One of the most important contributions, perhaps, will be a paper by Mr. G. W. Lamplugh on the 'Disturbance of Junction-Beds from Differential Shrinkage during Consolidation,' while an account by Mr. J. J. H. Teall of 'The Recent Work of the Geological Survey,' should be of interest. Dr. Smith Woodward has promised a paper which is sure to be of value. Mr. H. W. Monckton (recorder) will lay before the section some notes on 'Sarsen Stones,' Mr. C. C. Moote will contribute a paper on the 'Porosity of Rocks,' Mr. J. G. Goodchild will treat of the 'Origin of Eruptive Rocks,' while Mr. J. Lomas will discuss 'Some Glacial Lakes in Switzerland.' A number of papers dealing with the geology, or particular features of the geology, of various localities have also been arranged for, including an account by Mr. J. Lomas of the geology of the country around Southport. Considerable interest will attach to the first report of the committee appointed at Belfast to investigate the fauna and flora of the Trias of the British Isles. The committee have this year confined themselves to the study of footprints, and Mr. Beasley furnishes the bulk of the report.

In past years, it will be remembered, zoology and physiology have each been accorded a separate section at the meetings of the British Association. Last year, however, it was decided, in view of the close relation between the two subjects, to combine the two sections, and accordingly at Southport the physiologists will meet with the zoologists in Section D. The president of the united section is Professor Sydney J. Hickson. In the first part of his address he will consider the present position of the endowments and other encouragements for original research in zoological science in this country, and will point out the need there is for further cooperation and consultation on the part of working zoologists in matters affecting the common interests of the science. The second part of the address will be devoted to a consideration of the general problem of the influence of environment in the production of variation in animals. He will take the group of Cœlenterata for special consideration, and point out the bearing that the facts of variation in this group have upon the general question. The remaining work of the section seems likely to provide a very full program. No account of the physiological contributions is yet available, but the papers on zoological subjects alone constitute a fairly long list. A feature of the proceedings following the president's address will, it is hoped, be a discussion on fertilization, in which Professor Bretland Farmer, Dr. M. D. Hill, Professor E. B. Wilson, of Columbia University, and others, are expected to take part. As is the case in most of the sec-

tions, many of the contributions deal with highly technical subjects, which the specialist alone can fully appreciate; but mention may be made of a paper on 'Comparison of Terrestrial and Marine Fauna,' by Professor W. C. McIntosh, and of another on 'Corals,' by Professor J. E. Duerdon, of the University of North Carolina.

The subject of the address which Captain Ettrick W. Creak, C.B., R.N., proposes to deliver to Section E (geography), in his capacity of president of the section, is the connection between geography and terrestrial magnetism. He will point out that terrestrial magnetism is a subject of vital importance to navigation, and of growing interest to science, and after referring to the magnetic surveys of the globe which have in the past been carried out by land and sea, will direct attention to the vast secular changes which are occurring in the earth's magnetism, and insist on the necessity for keeping our magnetic charts up to date. He will then indicate the vast land areas still unvisited by the magnetic observer, in which travelers might find a field for useful work, and will have something to say about the instruments which should be employed. He will also refer to the far more extensive areas of the globe covered by water, in which practically no magnetic observations have been made for many years past, mainly owing to the lack of suitable vessels. The scientific nature of the presidential address is fully reflected in the program of the general work of the section. In the list of papers, records of journeys of exploration are conspicuous by their absence. Colonel Manifold, indeed, will discuss 'The Routes to the Yangtsze Valley,' and Mr. J. P. Thomson, founder and secretary of the Queensland branch of the Royal Geographical Society of Australia, has promised to give an account of the geography of Queensland, where he has traveled widely. It is also hoped that Lieutenant Shackleton will be able to contribute a paper on 'The National Antarctic Expedition,' in the first year's work of which he took so prominent a part. But the great majority of papers deal with the more purely scientific branches of geography. An important subject down for discussion by Colonel F. Bailey is the 'Denudation of Mountains and its Remedy.' More or less akin to this is 'The Afforestation of Water-works Catchment Areas,' a subject which will be dealt with by Mr. J. J. Parry, special attention being paid to the case of Liverpool. A paper of much practical interest to explorers should be that on 'Improved Methods of Survey for Travelers,' by Mr. E. A. Reeves, the Royal Geographical Society's map curator and instructor, while equally interesting and instructive in another direction will be Mr. E. D. Morel's account of the 'Economic Development of West Africa,' a topical subject of special importance. Other papers to be read before the section are the 'Geographical Distribution of Disease and Disease Carriers,' by Dr. L. Sambon; 'The Melting of Ice in Relation to Ocean Currents,' by Professors Pettersson and Sandström; 'The Importance of Echology to Geography,' illustrated by slides, by Mr. O. Darbishire; 'The Physical Geography of the Pennine Chain,' by Mr. B. F. Kendall; 'A Botanical Survey of Westmoreland and Cumberland,' by Mr. F. J. Lewis; 'Glareanus, a Sixteenth Century Geographer, and His Manuscript Maps,' by Mr. E. Heawood; and 'The Nomenclature of British Mountain Systems,' by Dr. H. R. Mill. A feature of much interest in the proceedings of the section should be the joint meeting which has been arranged with Section L (educational science), for the purpose of discussing the teaching of geography. Mr.

H. J. Mackinder, reader in geography at the University of Oxford, will open the discussion, and he will be followed by several others who have devoted special attention to this important branch of school work.

In view of the vital questions now at issue with regard to the fiscal policy of the empire, an unusually large attendance may be looked for at the meetings of Section F (economic science and statistics). So far as can be judged from the preliminary list of papers, those who follow the proceedings of the section will have no cause to grudge the time so spent. The subjects on which contributions have been promised are at once of wide general interest and of commanding importance in the life of the nation. As might be expected, not a few of the contributions are connected with the problems now immediately before the country, but the papers to be read and discussed are by no means confined to this subject. As a government official, Mr. E. W. Brabrook, C.B., who is this year president of the section, has naturally steered clear of the much debated question of the day. He has, however, chosen as the subject of his presidential address a topic always attractive, and one that closely affects the national welfare—namely, 'Thrift.' In virtue of his position as chief registrar of the Friendly Societies' Registry, Mr. Brabrook is peculiarly well qualified to speak with authority on this subject, and a highly-instructive address may be looked for. The great accumulation of funds in friendly and other societies and in savings banks will be noted, the principle upon which the legislature has hitherto dealt with these bodies will be defended and its satisfactory results pointed out. Incidentally a number of matters interesting to those who are concerned with provident institutions will be touched upon and discussed, and the general conclusion drawn will be favorable to these bodies. In the general program of the sectional proceedings, a complete day has been set aside for the consideration of the fiscal questions which Mr. Chamberlain has proposed for discussion. Dr. E. Cannan will discourse on 'The Shibboleths of Free Trade,' Mr. A. L. Bowley, the recorder of the section, will discuss 'The Application of Statistics to Economic Arguments,' making reference to methods of criticism, Mr. H. O. Meredith will relate the 'History of Retaliation,' and Mr. F. Bradshaw will give an account of 'The Commercial Relations between Canada and the United Kingdom,' an historical résumé from early times to the present day. It is also hoped that a day will be devoted to a discussion on 'Our National Income, and How to Spend it.' Sir Robert Giffen is expected to open the discussion. A subject that is attracting a good deal of attention just now is to be dealt with by Mr. Bosanquet, who will read a paper on 'Physical Deterioration and the Poverty Line,' criticizing the statistics advanced on the subject. Different aspects of taxation will be discussed in two or three contributions. 'Sinking Funds in Municipal Enterprise' will form the subject of a paper by Mr. S. H. Turner, of Glasgow University, who will insist on the necessity of distinguishing between sinking funds and depreciation in law and practice. Dr. B. Ginsburg will discuss the growth of rates, and a paper on a kindred subject will be contributed by Mr. J. G. Chorlton. Mr. Lees Smith, of Ruskin Hall, Oxford, has promised a paper on 'Karl Marx's Theory of Value'; and the work of the section will also include the consideration of the final report of the Committee on Legislation affecting Women's Labor. The report will show that information has been obtained on sev-

eral important questions, and that the acts so far passed by Parliament have been the cause of many benefits and of very little visible inconvenience.

The president of Section G (engineering) is Mr. Charles Hawksley. No information as to the subject of his address is available, but the program of the general work of the section shows that the engineers are likely to have a very interesting meeting. Apart from the papers to be read, the various excursions to important industrial works in the neighborhood, to which reference has already been made, should prove specially attractive to members of this section. An interesting contribution will be that by Lieutenant-Colonel Crompton, R.E., C.B., on 'The Problem of Modern Street Traffic.' This paper is intended to open a discussion in which municipal engineers, tramway engineers, police officials, automobilists, and others are invited to take part. A particular aspect of the general problem of vehicular traffic will be dealt with by Mr. J. Clarkson, in a paper on 'Steam Propulsion on Roads.' Mr. W. F. Goodrich will have much that is instructive to say on the subject of 'Refuse Destructors and Power Production,' and, among other contributions, will be papers by Mr. Bell, on 'Oil Fuel'; Mr. Woodhouse, on 'The Newcastle Power Works'; Mr. T. Parry, on 'The Water Supply of South-West Lancashire'; Dr. Campbell Brown, on 'The Growth of Organisms in Water Pipes,' and Mr. B. Hopkinson, on 'The Paralleling of Alternators.'

The address of Professor J. Symington, of Queen's College, Belfast, who is this year president of Section H (anthropology) will deal mainly with the significance of variations in cranial form, and will criticize the view recently revived by Professor G. Schwalbe that the fossil Neanderthal skull cap belonged to a species of *Homo* different from recent man. It will also consider the relation between the external and internal forms of the cranial wall. The papers accepted in physical anthropology include a study of the skulls from Round Barrows in Yorkshire, by Dr. W. Wright; papers on skulls from the Malay Peninsula, by Mr. N. Annandale, and on the physical character of the Andamanese, by Dr. Garsin; a note on Grattan's craniometrical methods, by Professor Symington; and important reports on Dr. C. E. Myers' work on the rank and file of the Egyptian Army, on Dr. W. H. R. Rivers' researches among the Todas, and on Mr. Duckworth's investigations among the ancient and modern populations of Crete. The committee on anthropometric methods has a valuable report to present, and that on the teaching of anthropology will probably report *ad interim*. Archeology will be unusually well represented. Mr. Arthur Evans, Mr. J. L. Myres and Mr. R. C. Bosanquet will offer reports on this year's excavations in Crete, Mr. J. Garstang and Mr. Currelly on recent work in Egypt, Mr. G. Clinch on 'A Surrey Monument illustrative of Certain Points in Stonehenge,' Mr. Annandale on 'Stone Implements from Iceland,' Dr. C. S. Myers on 'The Ruins of Kharga in the Great Oasis,' Mr. T. Ashly on 'Roman Work at Caerwent,' and Mr. Garstang on 'Ribchester,' while the usual report on the Silchester excavations may be expected to lead to some discussion. Professor Ridgeway will read a paper on the 'Origin of Jewelry.' General ethnography (with the exception of Dr. Rivers' work on the Todas) and folklore and comparative religion (with the exception of a paper by Mr. W. Crooke on 'Islam in Modern India') are as yet poorly represented, but this de-

fect will probably be remedied before the meeting.

Section K (botany) will meet under the presidency of Mr. A. C. Seward, whose address will be devoted to the subject of fossil plants. After referring to the importance of paleobotanical investigations, as affording evidence bearing on the interrelationships of existing classes and families of plants, the greater part of the address will deal with the leading characteristics and geographical distribution of the older floras of the world. The geographical distribution of extinct plants has received less attention than it deserves, but in spite of the meager character of the available data the subject is well worthy of consideration. The general facies of the vegetation of the Devonian, Carboniferous, Breccian, Triassic and Jurassic periods will be described, prominence being given to such facts as throw light on the methods of plant evolution during the Paleozoic and Mesozoic eras. The main object of the address, however, will be to draw attention to the conclusions which may be looked for as the result of a critical study of the geographical distribution of the floras of the past. As regards the general work of the section, Mr. W. Bateson and Miss E. R. Saunders will read papers on the new discoveries in heredity and will deal with the results of some cross-breeding experiments with plants, maintaining the view that these have arisen from a dicotyledonous ancestor by the union of its two seed leaves. Miss Ethel Sargant will open a discussion on the evolution of the monocotyledons, and Mr. C. C. Hurst will give an account of some recent experiments in the hybridization of orchids. Professor J. B. Farmer will lecture on epiphytes, Messrs. A. G. Tansley and F. F. Blackman will give an account of important recent advances in our knowledge of the green algæ, Dr. O. V. Darbishire will read a paper on the sandhill and saltmarsh vegetation of Southport, Miss Sargant and Miss Robertson on the seedlings of some grasses, Mr. Harold Wager (recorder of the section) on the staminal hairs of *Tradescantia*, and Professor T. Johnson on a willow canker. The report of the joint committee of Sections K and L on the teaching of botany in schools will be presented, as also reports on the investigation of the Cyanophyceæ and on the respiration of plants.

Section L (educational science) will this year meet for the third time, and so well has it justified its existence that it may now be regarded as an established institution. The president of the section is Sir William de Wiveleslie Abney, K.C.B., principal assistant secretary of the Secondary Branch of the Board of Education, from whom an instructive address may be expected. Following the course pursued at Glasgow and Belfast—a course which might, perhaps, usefully be adopted, in a measure at least, by some of the other sections—the organizing committee has decided to confine the discussions to a few subjects of wide general interest and importance. The first two days of the sectional proceedings will be devoted to an organized discussion on school curricula, based on a series of short papers of which copies will be distributed before the meeting. Papers have been promised by (amongst others) Miss Burstall and Messrs. M. E. Sadler, J. L. Paton, W. L. Fletcher (Liverpool Institute), John Adams and T. E. Page. There will be two main branches to the discussion, one relating to the character of the curriculum suitable for primary (preparatory) schools, the other to the curriculum suitable for

secondary schools. It is hoped that each of these subjects will be discussed very thoroughly. Naturally the latter, being the larger subject, will be the more fruitful in matters for consideration. The general questions which will be raised will be: What subjects, if any, all children should at first study in common; whether the training should not in all cases necessarily include literary instruction and practical instruction (science, drawing, manual and physical training, etc.); and how far up in the schools both these should be carried. Then will be considered at what stage, and to what extent, divergence from the general preparatory courses should take place, and the best curricula will be discussed for schools preparing for (1) commercial professions, (2) domestic professions, (3) engineering and applied science professions and (4) literary professions. Finally the relation in such schools between literary and practical branches of instruction will be dealt with. Besides discussing these important questions, the section will consider the reports of various committees on subjects deserving of careful attention. Four reports will be presented, relating to the conditions of health essential to the carrying on of the work of instruction in schools; the teaching of natural science in elementary schools; the influence exercised by universities and examining bodies on secondary school curricula, and also of the schools on university requirements; and the teaching of botany in schools. This last, as has already been stated, is the report of a joint committee of Sections K and L. Reference, too, has already been made to the meeting which Section L is to hold jointly with Section E for the purpose of discussing the teaching of geography.

*HIGH SCHOOL CHEMISTRY IN ITS RELATION TO THE WORK OF A COLLEGE COURSE.**

The object in discussing a subject of such latitude as the one assigned me I assume to be to suggest questions, invite criticism and point out defects rather than merits. Two distinct questions claim our attention in discussing the relation of high school chemistry to the work of a college course.

1. Who ought to decide what is the most suitable course for high schools, and how shall such decision be arrived at?

2. What is the most notable defect in the present arrangement and what is the remedy?

I shall also assume that the young man preparing for college should study chemistry by the same methods as the one who is to be a farmer or a merchant. Whatever method is good enough for one is none too good for the other. As the elements of reading or arithmetic are taught alike to the future mechanic and elocutionist or accountant, so differentiation in chemistry should begin with the higher branches only. The question is to find the best system for teaching the science. That question, however, being a matter of individual opinion, is subordinate to the one I purpose to discuss. Who shall be the arbiter and how shall decision be reached?

The methods of yesterday are not the same as those of to-day, and to-morrow will bring its own differences. A generation ago chemistry was taught by recitation and lecture work. Now the laboratory supplements and in some cases supplants these. All new methods tend to extremes; hence those in vogue to-day are not necessarily nor even probably better in every respect than those of

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yesterday, though they may have elements of superiority. A method, for example, which discards entirely the text-book, which does away with recitation, which omits theory, may have some excellent points, but as a whole it is abominable.

In former years it was the custom of college authorities to state the subject matter and largely the methods to be used in the high school which offered preparatory subjects, and other high schools made their own courses. At first this seems eminently appropriate, for the student must be prepared to take up such work as the college offers, at a given indicated point. The college, in that view of the case, rightfully dictated the work for secondary schools. The governing body of each institution was entirely distinct from that of the other, and the only harmonious articulation of the two was the arbitrary 'requisites for admission' to the college, and these differed with different institutions; hence a babel of courses, methods and results. With the growth in the western and central states of state universities, the gulf between high schools and colleges was more easily bridged. But in the east other forces have been at work. Cooperation—the organizing of associations for the teaching of history, English, physics and chemistry, associations in which college professors and high school teachers meet and together discuss methods and formulate systems—has been a powerful factor in bringing into closer union the two classes of institutions. 'Community of interests' is found as desirable here as among railroads, and it stamps our science teaching with twentieth century methods. It is a splendid illustration of this harmony that high school teachers are invited to speak on the same platform with college professors and university presidents, to discuss a common subject. It emphasizes what a few years ago was not so fully recognized, that high school teachers as a class are not a whit less conscientious, nor perhaps in a majority of cases less qualified for the work they have to do than are their college brethren for theirs.

I believe that colleges can not long afford arbitrarily to say, without consultation of secondary school teachers, that just so much ground must be gone over by just such a method, nor can the high school unadvisedly lay out its course. What can high schools do as feeders of the college? What ought they to be expected to do? Such vital questions can best be answered only by conference and cooperation; for while the professor may know far more of the objective intricacies of the science, he can not understand as the high school teacher does the subjective emanations from the gray matter of the boy's brain and how best to direct those emanations. What is the history, what the tendency of cooperation?

The first club of chemistry teachers known to the writer, for comparing methods of teaching, was the Boston Chemistry Teachers' Association, formed in 1891 at the suggestion of Miss Laura B. White. This club has been in existence ever since and continues to hold monthly meetings during the school year at the Girls' High School in Boston. It is an informal club without organization, but it has done much effective work.

The New England Association of Chemistry Teachers was organized in 1898, by about a score of teachers of the science. The association has grown to not far from 100 members scattered literally from Maine to California. Printed reports of the three meetings per year give full details of papers and discussions and are distributed to each member, besides which occasional records of chemical literature, books and articles are issued. So far as known to the writer, this is the oldest, and to the

present time the largest, organization of its kind in this country. Recently several other societies of a like sort have sprung into existence, one in California (the Pacific Coast Association of Chemistry Teachers) and one in New York state, while inquiries concerning the conduct of our association from western states indicate that others are in process of formation.

These organizations which are sure to increase in numbers and efficiency, will do a great work towards unifying chemistry teaching. It is to be regretted that thus far the high schools are doing the major part of this work. I believe the only organization which can remotely approach to the ideal is that in which both college and high school teachers take a common interest, and enter into the work with equal zeal. In establishing chemistry clubs, therefore, care should be taken that no one class of teachers forms the active membership to the exclusion of the other.

Other associations of chemical workers have grown up, especially as adjunct societies to the large educational organizations of the country, among which the National Educational Association stands preeminent. I need not refer to the science clubs which are a feature in every large college, nor to the American Chemical Society nor the American Association, for these are mainly concerned with research work and facts, rather than with teaching.

But the organization which is doing more than all others at the present time to articulate high school and college work is the College Entrance Examination Board. Originating in 1899 at a meeting of representatives of colleges and universities of the Middle States and Maryland, it has grown so as to include twenty-three institutions, and the second annual report states that of all the colleges and universities in the United States only one declines to accept its examinations for entrance, three of which have already been held. In such a concentration of forces there is enormous saving of time and a unification of college preparatory work.

There is a second relation which I wish particularly to emphasize in our discussion. Many of our high schools give a fairly good course in general chemistry—experiments, theory and principles—some taking two years and including qualitative analysis, and a little quantitative work. Yet in a great majority of the higher institutions the work must be repeated.

To be obliged to go over again in college the preparation of oxygen, the properties of sulphur, the compounds of iron, which he has already studied experimentally and theoretically, the student regards as a useless waste of time, and reasons that if he must take the subject in college he had better spend his time in the preparatory school on some other branch, the rudiments of which will not be repeated. Thus is high school chemistry placed at a disadvantage in comparison with other elective subjects.

Two sets of reasons are advanced for this failure of the colleges to recognize preparatory chemistry from the fitting school. First and chiefly, because in a majority of such schools the student does not go deep enough into general chemistry to warrant his taking up at once the higher branches—quantitative or even qualitative analysis. He has not had theory enough nor practise enough.

A second reason is that some students offer chemistry for admission, others do not. Hence there must be an elementary course in college for those who have not had the subject prior to entering, and into this class are also put those who have studied chemistry in the schools. Thus side by side in the laboratory, taking also the same lecture notes, are those who do

not know an element from a compound, and those who have passed the searching college-entrance examination.

Wishing to know what is the actual practise in the higher institutions. I sent to each of the twenty-three colleges and universities that contribute to the College Entrance Examination Board, the following among other questions: 'Are those students that have passed elementary chemistry on entrance obliged to take general chemistry again if they continue the subject, or may they go on at once with more advanced work?' The College Entrance people were selected because they are united on a definite object, and are supposed to allow candidates for admission to offer chemistry. The result would probably not vary much if other colleges had been interviewed. Of twenty-three replies to this question (for every one answered it) seventeen are to the effect that the subject must be repeated, though a few say that if the course has been as thorough in the high school as it is in the particular college, the student may go on, implying at the same time that this rarely, if ever, happens. In two cases chemistry was not allowed as an entrance elective. One states unqualifiedly that students may go on, another that they may, but that very few continue the subject. Thus the almost unanimous verdict is: *Repeat.* And the offense with which the high school is charged is *inadequate preparation.*

Wishing to get at the evidence which weighed in the minds of the judges, I put to the same twenty-three institutions this question: 'In what part of the work do you find those offering chemistry most deficient?' To this question fifteen direct answers were given, and as they form the important evidence on which my client is convicted, I quote them.

ANSWERS.

1. Elementary general principles.

2. A comprehension of underlying principles. Pupils acquire facts but do not understand their relation to general principles.

3. Want of application.

4. Work is not thorough; mostly taught from books, ground covered too great for time devoted to it.

5. Elementary logic. Students coming to college are very deficient in reasoning.

6. Equations and laboratory work.

7. Making, putting up and using apparatus; a thorough knowledge of the non-metals; quantitative experiments.

8. Their failings will vary with the instruction they have received.

9. In general.

10. Perhaps theoretical more than descriptive.

11. Have generally 'done' a large number of experiments, but are sadly deficient in chemical laws.

12. In theory and in knowledge of metals.

13. Equations and familiarity with fundamental principles. Three fourths of the time at high schools is wasted in trying to cover too much ground.

14. They fail because they will not study, and I think in many cases they were never taught how to study.

15. The fifteenth and last is a venomous arraignment of high schools, untrue as it is unkind. Its author says: "The preparatory schools are not in a position to give students anything like the comprehensive instruction in elementary chemistry. In the first place, they can rarely afford to hire a chemist to give the instruction. They only get a school teacher who has a smattering of chemistry, and not a real chemist. In the second place, they never have much apparatus, so at best preparatory chemis-

try does not amount to much. The student does not get enough of it to amount to a row of pins. Now, on the other hand, the university professor begins at the beginning. He can not skip oxygen or hydrogen or nitrogen or water or the atmosphere because the students have heard these names once or twice in school,'' etc.

Such a scathing anathema, besides degrading the high school teacher's work, and elevating to the pedestal the university professor's, shows ignorance of high school chemistry as taught to-day. Hundreds of these schools have as teachers graduates in chemistry from colleges and technological schools, and scores have degree men from German and American universities who are 'real chemists,' and whose work compares favorably with that done in college. Again, it is the exception that high schools now building and recently built are not well equipped with laboratories. Within ten miles of this spot there is a high school chemical laboratory on which there was laid out for repairs alone last year more than $10,000, and another high school plant in the same city whose original cost more than thirty years ago was $40,000. Two weeks ago, happening to be in a city of only 25,000 people, in another state, I visited a high school laboratory better equipped than any college laboratory doing the same grade of work that it has been my fortune to examine.

This statement might have been true twenty-five years ago; it is probably true now of some remote country high schools. Its iteration by only one out of twenty-three shows that most colleges recognize the improved conditions in high school work.

Yet from these replies of representative higher institutions there seems no doubt that preparatory schools are trying to do too much and are really doing too little. Where is the fault, and what is the remedy?

A majority of the replies state distinctly that the deficiency is in laws and general principles; that students can not sufficiently correlate facts and theories. The teaching of laws, general principles and chemical theory assumes, therefore, paramount importance and constitutes the great desideratum. Elsewhere I have dwelt upon the importance of theory teaching, and the verdict of these colleges is a convincing corroboration.

While the inculcation of principles and laws is acknowledged by every instructor to be the most difficult part of his work, something to be avoided by the easy-going teacher and slothful student, yet it is recognized as the only thing that can give a broad grasp of the subject and, with requisite experiments, yield the largest results. The tendency in some quarters to omit the application of these broad principles, to abolish the text-book, to abuse the laboratory by excessive use to the exclusion of recitation and lecture, should be viewed with only temporary alarm, for such abnormalities will finally right themselves when the ideal course is adopted.

Entering college on chemistry is a comparatively recent thing. The colleges are the pacemakers, and the high schools are trying their best to keep up.

In the elective system that subject must take the place of so much mathematics, or some ancient or modern language. To be the equivalent of any one of these, a great deal of ground must be covered—the non-metals and the chief metals, laws and general principles, the chemical theory including nomenclature, symbolization, etc. The fitting schools have tried to cover all this extensive ground, and, as most of these schools give but one year of three to five hours per week to chemistry, the result has been—to borrow Mr. Morgan's phrase of 'undigested securities'—a vast amount

of *undigested facts.* Little wonder the students are deficient in 'elementary logic,' in power of 'application,' and that 'their failures vary with the instruction they have received,' or failed to receive. The colleges, on the other hand, have set examinations to fit a one-year crammed course and have admitted students that were confessedly unable to go on with the higher branches of the subject, and were thus forced to repeat in a more thorough manner the work of the preparatory school. This unnatural loss of time and energy can not long continue in a quickened educational atmosphere. Two roads lead out of the woods. Let the authorities explicitly state that thorough preparation in the entire field of general chemistry can not be had in less than two years of five hours per week in a well-equipped laboratory. Make the examination rigid enough to meet this demand, and when the student has entered college, do not require him to repeat his work, but give him advanced standing, as he would have in Latin or mathematics. This is one road. The other, and I believe better one, is: Limit the requirement to one year's work; cut out the consideration of metals except as they incidentally appear in salts and acids radicals; demand a thorough course in the non-metals, the chemical theory, laws and general principles. Then, as in the other case, do not ask the student to waste another year or half year in repetition, but give him advanced work, beginning with metals.

Either of these plans would relegate the rudiments of the science to the high schools as is fitting. Why should the college teach high school chemistry any more than high school English, or high school algebra? I believe it is *almost*, if not altogether, as important that every high school graduate should know something of the composition of the air he breathes, the constituents of the food that nourishes him and the reactions of the fuel that keeps him warm, as to know the binomial theorem or the proof of the *pons asinorum.* Why require the latter as a prerequisite to entrance upon a liberal education, and omit the former? When colleges take the same stand concerning the fundamentals of chemistry which they assume in English and in mathematics, a great advance will have been made. As Cæsar is read in a preparatory Latin course, and not again studied in college, let oxygen, carbon and silica be relegated to the secondary schools, and the college course begin with metals, analysis, etc. This division line is purely arbitrary, but it serves my purpose of illustration. Any other division mutually agreed upon by conference of representatives of the two classes of institutions would serve equally well. I believe it to be entirely practicable for a conference of college and high school men to lay out a course with experiments to cover the required ground so satisfactorily that no repetition shall be needed.

I believe this subject is worthy of the most serious consideration from an economic standpoint. Last year President Butler gave an address before this association on the waste of time between the primary school and the university, and this week the discussion has been renewed under other forms by the college presidents. Right here is our chance for contribution. Save a year in chemistry. I believe it to be the plain duty of colleges and high schools to cooperate in formulating such a plan. Especially it seems to me that a strong point can be scored by the examination board that has undertaken the task of unifying entrance examinations and preparatory work, of setting a model which the high schools shall attain unto, in order that a

year of school life be not lost, that the student may begin in college where he leaves off in the high school, with preliminary work reasonably complete and satisfactory.

Rufus P. Williams.

SCIENTIFIC BOOKS.

Municipal Public Works, their Inception, Construction and Management. By S. Whinery, Civil Engineer. New York, The Macmillan Company. 1903. 8vo. Pp. 241. 8½ in. by 5¾ in.

This is an excellent book on a subject which is more and more attracting the attention of the general public. It is written by an experienced engineer 'for the inexperienced city official and for the urban citizen.' Although it treats of engineering subjects it is not a book of engineering. It is rather a book of public policy in municipal engineering affairs, and as such it differs from many books which have recently appeared with similar titles.

The early chapters in the book are elementary, describing the scope of municipal works, the relation to them of the engineering departments and the manner of financially providing for their support. The author then takes up the question of contract work, and discusses various details of it, such as advertising, preparing specifications, opening bids, awarding contracts, supervising the work, etc. He favors contract work as opposed to work done directly by the city, but points out many weak points in the ordinary contract. Contractors he divides into three classes—the honest and responsible contractor, the irresponsible and unreliable contractor and the boodler; and his descriptions of the conditions which operate to develop these different individuals are most instructive. He is strongly opposed to the compulsory award of contracts to the lowest bidder, and believes that in this, as in many other matters, the engineer or the commissioner should have more latitude and be held personally responsible for the result. In some of these matters the author is at variance with present custom, his theory being, apparently, that there is less chance of bad results due to the use of autocratic power by an occasional dishonest or unfit official than by the operation of laws which continually hamper honest officials and which are ignored or broken by the dishonest ones.

Perhaps the most valuable portion of the book is that which relates to the financial side of municipal works. The subjects of guarantees, special assessments, uniform accounts, municipal ownership, quasi-public corporations are treated in special chapters. His criticisms of the ordinary methods of municipal accounting are severe, but none too severe, as any one will admit who has attempted to compare the cost of any class of municipal work for different cities. And he is quite right when he says that many questions of public policy are being to-day obscured because of false statements issued with no intention to deceive, but simply as a result of bad bookkeeping. Among these questions he places that of 'municipal ownership' of public utilities, and while not wholly deprecating the modern trend toward public purchase of private water works, electric light works, etc., he believes that such changes should be made only after a more complete study of all the financial elements which enter into the question than is usually given to it. His comments upon the proper treatment of such matters as maintenance, operating expenses, interest, depreciation, sinking funds, in connection with the valuation of private property are worthy of serious consideration.

Instead of the wholesale municipal assumption of public utilities he favors private ownership under suitable control, and in the last chapter he outlines a plan and offers it as a solution of this vexed question. He would organize all quasi-public corporations under a general state law, similar in its general features to the present interstate-commerce law, and would make the law 'so radical and far-reaching as to assume, within limitations, the absolute control of quasi-public corporations and of their relations between them and the municipal corporations.'

Whether or not the reader agrees with all the author's conclusions upon the questions

discussed, he will admit that his points are well argued and that the book has given him a clear outlook upon the broad subject of municipal works.

George C. Whipple.

DISCUSSION AND CORRESPONDENCE.

ELECTRICITY AT HIGH PRESSURES.

To the Editor of Science: Some three or four years ago* I put forward the idea that just as with increase of vacuum and potential the Roentgen rays become more and more penetrating, there may possibly be produced, when cathode ray ions (electrons) move with the very highest velocities, rays that penetrate considerable thicknesses of nearly all bodies without undergoing absorption. Interstellar space may be traversed not only by light and heat waves, but also by rays of the more recently discovered penetrating kinds including those of extreme penetrating powers above assumed as possible.

From what source would such highly penetrating rays as are referred to come? Might they not come from matter (electrons or assemblages of electrons called atoms, or even small masses of matter) moving with such very high velocities as are somewhat comparable with the velocity of light? These assemblages of electrons on impact would probably give Roentgen rays of all orders up to the very highest or most penetrating. Such rays would be absorbed only in larger or denser masses of matter and the absorption would ordinarily be undiscoverable. The celestial bodies, as the stars, planets, etc., would probably absorb the rays, and the rays in being so absorbed would add energy to the masses, tending to some extent to keep up their temperature.

The natural question arises as to whether there are any existing conditions under which the smallest particles could attain high velocities. When an extremely minute particle of matter near the sun or in the outer envelope of gas around the sun is of a nature to absorb the radiation, a radiation pressure will be exerted upon it which may, if the particle is small enough, be in excess of gravitational force. Such particles continuously expelled, in virtue of the excess of radiation pressure over gravitation, may give rise to the coronal streamers around the sun. If the condition just pointed out be possible, the particle will, under the difference of force, be accelerated outwardly from the sun, and continue to move away with an acceleration which, though diminishing, is still an acceleration. Such particles would naturally be expected to leave or be driven away from any hot star.

That a particle once started away will continue moving outwardly with an acceleration, follows from the fact that both the radiation pressure and gravitation vary as the inverse squares of the distances. This means that if a particle is moving towards the sun under the influence of gravitation, it will not at any time be stopped by the radiation pressure unless it be subdivided into smaller particles. It also means that any set of particles moving from the sun under radiation pressure in excess of gravitation must continue forever moving away, unless such particles are brought together into large masses or collide with other masses. It is possible that the limiting velocity which could be attained would be the speed of light waves in the ether. Such rapidly moving particles, whether consisting of many molecules or atoms (groups of electrons) or consisting of separate electrons or ions would probably, on striking other particles or masses, give out intense radiation of the Roentgen ray order, and accompany the same by heat radiation, or visible radiation, or both. Such particles might even serve to illuminate some of the apparently cold nebulæ, either by the impact generating heat and light, or by fluorescence.

Here, then, is the outline of a new corpuscular theory of energy conservation, which is not the Newtonian corpuscular theory, but which supplements the undulatory theory in providing a mode of recovery for at least a portion of the energy of radiation. Any particle which is set in motion by the radiation pressure is within limits converting the energy of radiation into mechanical move-

* 'Electricity at High Pressures,' lecture before the New York Electrical Society, March 29, 1899.

ment or moment, which movement continues until such particle meets an obstacle and the energy is again reconverted to heat, light and to those forms of obscure radiation, more or less penetrating to ordinary matter.

It is doubtful whether radio-active substances like radium are the fluorescent detectors of such rays as reach us from space, and which are not absorbed by our atmosphere. The simpler hypothesis is that of atomic instability. But the hypotheses which have been outlined above—and they are, of course, only scientific speculations or hypotheses as yet—naturally suggest lines of investigation which are desirable to be carried out. In that way only can any truth, if it exists in these ideas, be determined; or the ideas disproved, as the case may be.

Elihu Thomson.

A POSSIBLE USE FOR RADIUM.

On the authority of M. Curie radium is worth about one million dollars a pound. This estimate is based on the cost of isolating this rarest, newest and most wonderful of the metals, rather than upon its uses to practical people.

Utilitarians may demand: 'Of what use is radium?' Sir Oliver Lodge has said this is difficult to answer for people who wish to make money out of it, but although at present radium grinds no axes, it is held in great estimation by physicists who see in its amazing energy possible solutions for old problems and materials for new ones. A British writer in the *Daily Graphic* of July 13 points out one direction in which a study of the properties of radium may prove of the greatest benefit to mankind, and that is the analogy between its rays and those of luminous insects. As Sir Oliver Lodge remarks, if we could discover the secret of the fire-fly's power to convert some unknown source of energy into light, we could produce light without heat.

Hope is expressed that the study of radium may lead us to a method of obtaining light in a cheaper and more convenient manner than any now known.

X.

SHORTER ARTICLES.

THE FISHES OF THE AFRICAN FAMILY KNERIIDÆ.

In 1866 Dr. Steindachner introduced into the ichthyological system a peculiar western African fresh-water fish which he called *Kneria angolensis* and referred to the family Acanthopsidæ or Cobitidæ. Two years later (1868) Dr. Günther added another species from central Africa (*Kneria spekii*) and ranked the genus as the representative of a peculiar family—Kneriidæ. He placed it as an 'Appendix to the Cyprinidæ,' and there it has ever since been allowed to remain, but I have always felt convinced that it was not at all related to the Cyprinids or Plectognaths even. Very recently data have been acquired which may help us to a solution of the taxonomic problem.

In 1901 Dr. Boulenger made known a remarkable pigmy fish (30 mm. long) from the upper Nile (Fashoda) which he named *Cromeria nilotica* and referred to the family Galaxiidæ, thinking that it 'appears to be most nearly related to *Galaxias*.'

It is very unlikely that the tropical fish should be a member of a family all of whose certain representatives are characteristic of the cool and cold waters of the southern hemisphere and I was inclined to believe that it was really related to the Kneriidæ. An important paper just published by Dr. Swinnerton appears to confirm this view.

In the *Zoologischer Jahrbücher* (Anatomie) published in June, 1903 (pp. 58–70), Dr. Swinnerton has given an article on 'The Osteology of *Cromeria nilotica* and *Galaxias attenuatus*' and made known some extremely interesting results. It appears that there is no relationship between *Cromeria* and the *Galaxiids*, and that *Cromeria* belongs to a peculiar family remarkably distinct from any other known unless it be that of the kneriids. To that, indeed, it seems to belong. It has the same general form, the same arrangement of the fins, the projecting snout or upper jaw, the toothless trenchant jaws, the absence of pharyngeal teeth, the three branchiostegal rays, the very narrow branchial apertures, and the simple air-bladder. Indeed, in all essential

respects, *Cromeria* appears to agree with *Kneria*. There are, however, two notable discrepancies.

Kneria has 'the margin of the upper jaw formed by the intermaxillaries,' according to Dr. Günther, while in *Cromeria* Dr. Swinnerton found that 'both premaxilla and maxilla are small and edentulous,' and that 'the latter overlaps the former dorsally and enters largely into the formation of the gap.' In view of the very small size of the fishes and the ambiguous character of the mouth parts, the apparent difference may be rather nominal than real.

Kneria has its body 'covered with very small cycloid scales,' while *Cromeria* has the body 'naked.' Further, *Kneria* has a normal tail, while *Cromeria* has a membranous extension from the caudal above and below. It is possible that both of these characters may be indicative of immaturity (as analogous ones are in some other fishes) but it may be better for the present to assume that the two genera *Kneria* and *Cromeria* are distinct; that they are related there is little doubt.

The family, as represented by *Cromeria*, is so remarkably distinguished by osteological characters, especially the attachment of 'the greatly elongated arm of a bifurcated post-temporal to the supra-occipital bone,' that it should be isolated as the representative of a peculiar superfamily—Knerioidea. As Boulenger and Swinnerton have indicated, the scapular arch being destitute of a mesocoracoid, the group may provisionally be associated in the same great group as the pikes and killiefishes—Haplomi—or, perhaps better, in the group Iniomi, inasmuch as the family agrees with those fishes in their technical characters. Whether such an association would be natural will be for the future to determine.

THEO. GILL.

THE FLORA OF THE SERPENTINE BARRENS OF SOUTHEAST PENNSYLVANIA.

PARTS of Montgomery, Delaware, Chester and Lancaster Counties, Pennsylvania, are noted from a geologic standpoint for the presence of outcrops of serpentine rock. This rock formation is confined to the district southwest of the Schuylkill River, extending in a somewhat southwestward direction into Maryland, near the lower Susquehanna River. The largest outcrops near Philadelphia occur in the neighborhood of Lima, Delaware County, at Newtown Square, at places north and southwest of West Chester, while isolated patches exist south of Bryn Mawr and northwest of Media. There seems no doubt but that all the serpentines in southeast Pennsylvania are altered igneous rocks, either pyroxenites or peridotites.*

The flora of the serpentine exposures, which are always more or less barren in appearance, is peculiar. The eye of the botanist, or of the observant layman, is at once arrested by the association of the characteristic species which make up the serpentine flora, because it is sharply demarcated from the flora of the surrounding country. The botanist can identify the serpentine areas, where the rock is covered by a shallow soil, by the vegetation alone, for the species which are character plants, although occurring elsewhere in the region, are here grouped together in such a manner and in such number, as to delimit sharply these areas from the surrounding country. The serpentine plants taken together, therefore, form islands set down in a sea of other vegetation with a boundary as well characterized as the shore of an oceanic island, and with tension lines induced by the struggle for existence as sharply drawn as the shore line against which the storm waves beat. This sharp delimitation of the boundaries of the serpentine areas is emphasized by the fact that these areas are rarely cultivated, but are surrounded by rich cultivable land from which the original vegetation has been removed by man. Many of the plants found on the serpentines have survived, therefore, such vicissitudes and have persisted on the barrens, while the same species have been exterminated in the cleared land. This fact, however, does not militate against the unique character of the serpentine flora, because the forest, which exists on soils other than the serpentine, is

* Rand, Theodore D., 'Notes on the Geology of Southeastern Pennsylvania,' *Proc. Acad. Nat. Sci. Phila.*, 1900, p. 305.

of an open type with the presence of a large number of shade-loving plants, such as *Sanguinaria canadensis* L., etc., which are not found as constituents of the barren flora.

Ten representative serpentine barrens were studied by the writer, viz:*

A. Glenriddle, Delaware County, Pa., on the road leading to the borough town of Lima.

B. Serpentine in the valley west of Black Horse Hotel.

C. Serpentine east of Black Horse Hotel.

D. Serpentine at Williamson School.

E. Serpentine lying between Newtown Square and Darby Creek.

F. Serpentine opposite Castle Rock on east side of Crum Creek along Preston Run.

G. Serpentine near Westtown, Pa.

H. Pink Hill near Lima, Delaware County, Pa.

I. Brinton's Quarry near Westtown, Pa.

Ecologically the flora of the serpentine barrens belongs to the mixed deciduous forest and barren treeless formations. Several plant associations are recognizable, so that an ecologic classification of the plants is as follows:

Mixed Deciduous Forest Formation.
- *Juniperus-Acer-Nyssa-Quercus Association.*
- *Sassafras Association.*
- *Aspidium-Asplenium Association.*
- *Dicksonia Association.*

Barren Treeless Formation.
- *Cerastium Association.*
- *Phlox Association.*
- *Deschampsia Association.*
- *Carex-Eleocharis Association.*
- *Spiræa Association.*
- *Rosa Association.*
- *Rubus Association.*
- *Kalmia Association.*
- *Smilax Association.*

These formations and associations will be described as they exist on the several serpentine areas mentioned. They are controlled largely by edaphic conditions. Thus the forest type exists where the geologic formation is covered by a surface layer of soil of some depth. The barren treeless formation exists where the serpentine rock is exposed with little or no surface soil. Where springs occur and the soil is wet, the character of the associations is determined by the amount of soil water.

A. Serpentine at Glenriddle, Pa.

The barren above Chester Creek at Glenriddle along the road leading from that place to Lima is distinguished by the dominance of *Quercus stellata* Wang. [*Q. minor* (Marsh.) Sarg.],* *Quercus nigra* L. [*Q. marylandica* Muench], *Quercus alba* L., *Acer rubrum* L., *Juniperus virginiana* L., *Castanea sativa* Mill. var. *Americana* Gray [*Castanea dentata* (Marsh.) Borkh.], *Sassafras officinale* Nees [*S. sassafras* (L.) Karst.], and *Cornus florida* L. (Mixed Deciduous Formation *Juniperus-Acer-Nyssa-Quercus Association*). The secondary species beneath the shade formed by the above-mentioned are *Rhus glabra* L., *Viburnum dentatum* L., *Vaccinium stamineum* L. [*Polycodium stamineum* (L.) Greene], *Gaylussacia resinosa* Torr. & Gray [(Ait.) Torr. & Gray], *Vaccinium pennsylvanicum* Lam., *Viburnum acerifolium* L. and *Salix tristis* Ait. The lianes, or climbing plants that festoon the trees, are *Vitis æstivalis* Michx., *Smilax rotundifolia* L., *Smilax glauca* Walt., *Rhus toxicodendron* L. [*R. radicans* L.]. The herbs found here are *Hieracium venosum* L., *Pteris aquilina* L. [*Pteridium aquilinum* (L.) Kuhn], *Antennaria plantaginifolia* Hook. [(L.) Richards], *Baptisia tinctoria R. Br.* [(L.) R. Br.], *Rubus triflorus* Richardson [*R. Americanus* (Pers.) Britton], *Potentilla canadensis* L., *Rumex acetosella* L., *Veronica agrestis* L., *Hypoxis erecta* L. [*H. hirsuta* (L.) Coville], and *Lysimachia stricta* Ait. [*L. terrestris* (L.) B. S. P.], all species usually found in dry situations like the sandy pine barrens of New Jersey. In fact, there is a striking similarity in the floras

* The map used in this botanic survey accompanies Penn. Second Geological Survey, Delaware, Part. I., C. 5.

* Names according to Gray, sixth edition, with names in parenthesis according to Britton's 'Manual of the Flora of the Northern States.'

of the serpentine barrens and the pine barren region of New Jersey.

B. SERPENTINE IN THE VALLEY, WEST OF BLACK HORSE HOTEL.

Here is found a typical exposure of serpentine rock. The barren treeless areas (BARREN TREELESS FORMATION) are characterized by the clumps of *Cerastium oblongifolium* Torr. [*Cerastium arvense* L. var. *oblongifolium* Holl & Britt.] (*Cerastium Association*), *Panicum latifolium* L., *Rumex acetosella* L., *Trifolium repens* L. Near by on somewhat similar barren areas occur thickets of green briars *Smilax rotundifolia* L., *Smilax glauca* Walt. with *Juniperus Virginiana* L. and *Nyssa sylvatica* Marsh rising out, as solitary specimens, from the tangled mass of briars (*Smilax Association*). *Rubus villosus* Ait? (Gray) [*R. nigrobaccus* Bailey], *Rosa lucida* Ehrh. and *Spiræa salicifolia* L. form pure growths (*Rubus, Rosa, Spiræa Associations*), while separating these are grassy stretches, where the botanist finds *Œnothera fruticosa* L. [*Kneiffia fruticosa* (L.) Raimann], *Cerastium oblongifolium* Torr., *Arabis lyrata* L., *Deschampsia cæspitosa* Beauv. (*Deschampsia Association*), *Sisyrynchium angustifolium* Mill., *Senecio aureus* L. var. *balsamitæ* Torr. & Gray [*Senecio balsamitæ* Muhl.], *Geranium maculatum* L. The swampy areas, formed by springs, support *Carex utriculata* Boott., *Eleocharis ovata* R. Br., *Danthonia sericea* Nutt., *Tradescantia pilosa* Lehm. (*Carex-Eleocharis Association*).

In an adjacent barren (*C*), a stream flows through the woods formed by *Acer rubrum* L., *Liriodendron tulipifera* L., *Juniperus virginiana* L. and *Nyssa sylvatica* Marsh. Along the borders of this stream, and therefore in wet soil, grow *Lindera benzoin* Blume [*Benzoin benzoin* (L.) Coulter], *Aspidium acrostichoides* Swartz [*Dryopteris acrostichoides* (Michx.) Kuntze.] and *Asplenium trichomanes* L. (*Aspidium-Asplenium Associations*).

D. SERPENTINE AT WILLIAMSON SCHOOL.

The dominant trees on the serpentine barrens at Williamson School are *Quercus alba* L., *Quercus rubra* L., *Quercus stellata* Wang. [*Q. minor* (Marsh.) Sarg.], *Quercus nigra* L. [*Q. marylandica* Muench.], *Acer rubrum* L., and *Juniperus virginiana* L., while associated with these trees are *Sassafras officinale* Nees [*S. sassafras* (L.) Karst.], *Rhus glabra* L., *Kalmia latifolia* L. (*Kalmia Association*), *Salix tristis* Ait., and as lianes, *Vitis æstivalis* Michx., *Ampelopsis quinquefolia* Michx. [*Parthenocissus quinquefolia* (L.) Planch.] and *Smilax rotundifolia* L. The following herbaceous plants grow on the barrens here, *Pteris aquilina* L. [*Pteridium aquilinum* (L.) Kuhn], *Senecio aureus* L. var. *balsamitæ* Torr. & Gray [*Senecio balsamitæ* Muhl.], *Geranium maculatum* L., *Trifolium agrarium* L. [*Trifolium aureum* Poll.], *Aspidium acrostichoides* Swartz [*Dryopteris acrostichoides* (Michx.) Kuntze] and *Castilleia coccinea* Spreng [(L.) Spreng].

E. SERPENTINE AT NEWTOWN SQUARE.

The dominant trees of this serpentine outcrop consist of the chestnut *Castanea sativa* Mill. var. *Americana* Gray [*C. dentata* (Marsh.) Borkh.], the red maple, *Acer rubrum* L., the beech, *Fagus ferruginea* Ait. [*F. americana* Sweet], black cherry *Prunus serotina* Ehrh., *Quercus rubra* L., *Quercus alba* L., *Quercus nigra* L. [*Q. marylandica* Muench.] and *Juniperus virginiana* L. As secondary species of this forest occur *Amelanchier canadensis* L. [(L.) Medic.], *Sassafras officinale* Nees [*S. sassafras* (L.) Karst.], *Carpinus caroliniana* Walt., *Corylus americana* Walt., *Rosa lucida* Ehrh., while as climbing species *Smilax rotundifolia* L., *Vitis æstivalis* Michx., *Ampelopsis quinquefolia* Michx. [*Parthenocissus quinquefolia* (L.). Planch.] form impenetrable thickets. *Vaccinium pennsylvanicum* Lam., *Gaylussacia resinosa* Torr. & Gray [(Ait.) Torr. & Gray] form the undergrowth associated with three ferns, *Aspidium acrostichoides* Swartz [*Dryopteris acrostichoides* (Michx.) Kuntze], *Asplenium trichomanes* L. and *Dicksonia pilosiuscula* Willd. [*Dennstædtia punctilobula* (Michx.) Moore], *Galium aparine* L. (*Aspidium-Asplenium, Dicksonia Formations*). The treeless barrens support *Cerastium oblongifolium* Torr., *Senecio aureus* L. var. *balsamitæ* Torr. & Gray

[*Senecio balsamitæ* Muhl.] and *Erigeron* Pers. [(L.) Pers.] (BARREN TREELESS FORMATION. *Cerastium Association*).

F. EAST SIDE CRUM CREEK ALONG PRESTON RUN.

A large part of this exposure is treeless, and upon the broken-down serpentine rock grow mats of *Phlox subulata* L. (*Phlox Association*), *Trifolium agrarium* L. [*T. aureum* Poll.] *Pteris aquilina* L. [*Pteridium aquilinum* (L.) Karst.], *Verbascum blattaria* L., *Panicum latifolium* L., *Potentilla canadensis* L. and *Cerastium oblongifolium* Torr. (*Cerastium Association*). The trees are the same as the botanist finds on the other serpentine barrens mentioned. Thickets of green briars are also characteristic of the treeless areas here.

A study of the flora of these rocky exposures reveals the fact that the same association of species is not found on all of the serpentine barrens. The several component species differ as the localities differ, although the same general character of the vegetation is preserved by the presence of several dominant plants, found on all of the barrens. The red cedar *Juniperus virginiana* L., the barren oak, *Quercus nigra* L. [*Q. marylandica* Muench.] the white oak, *Quercus alba* L., the sour gum, *Nyssa sylvatica* Marsh., the sassafras, *Sassafras officinale* Nees [*S. sassafras* (L.) Karst.], the smooth upland sumac, *Rhus glabra* L., the red maple, *Acer rubrum* L., may be said to be the dominant character species, while on most of the barrens, although not found on all, occurs the chestnut, *Castanea sativa* Mill. var. *americana* Gray [*C. dentata* (Marsh.) Borkh.]. When the growth of these trees is dense the serpentine areas are rendered impenetrable in many places by the green briars, *Smilax rotundifolia* L., *Smilax glauca* Walt., the lianes, *Vitis æstivalis* Michx. and the Virginia creeper, *Ampelopsis quinquefolia* Michx. [*Parthenocissus quinquefolia* (L) Planch], which festoon the trees and intertwine with each other to form a dark gloomy forest inhabited by the cotton-tail rabbit. Where the ground is too barren to support trees, which usually grow in situations where there is considerable surface soil, the green briar, *Smilax rotundifolia* L. associated with *Smilax glauca* Walt. covers the ground with a dense growth separated by intervals of grass, where the botanist finds the small sundrops, *Œnothera fruticosa* L. [*Kneiffia fruticosa* (L.) Raimann], tufted hair grass, *Deschampsia cæspitosa* Beauv., associated with the blackberry, *Rubus villosus* Ait? (Gray) [*R. nigrobaccus* Bailey], and meadow-sweet, *Spiræa salicifolia* L. These treeless areas can be distinguished at a distance by the clumps of briars, by the presence of sentinel-like red cedars, and by an occasional sour-gum tree.

The one herb found on all of the serpentine exposures is the barren chickweed, *Cerastium oblongifolium* Torr. [*C. arvense* L. var. *oblongifolium* Holl & Britt.], which varies from a dwarf cespitose herb to one that, taller and more distinctly branched, covers acres of ground. Some of the barrens are distinguished by the presence of matted growths of the moss pink, *Phlox subulata* L. Such are the barrens at Pink Hill (*H*) and along Preston Run (*F*), where extensive areas are covered by this herb associated with the barren chickweed and the wooly blue violet, *Viola ovata* Nutt. Upon one or two of the barrens, viz., Westtown, Pa. (*G*), and Edgmont, Pa.,* grows the fame flower, *Talinum teretifolium* Pursh. This plant is clearly controlled in its distribution by edaphic conditions, for it is found, and its nearly related species, *Talinum rugospermum* Holzinger, on a variety of rock formations throughout the eastern United States.† The barren at the Williamson School is noted for a growth of laurel, *Kalmia latifolia* L., dwarf willow, *Salix tristis* Ait., and until recently was visited by botanists for the scarlet painted-cup, *Castilleia coccinea* Spreng [(L.) Spreng].

* On the authority of Mr. Benjamin H. Smith, who ascertained the locality from Mr. Witmer Stone.

† Harshberger, J. W., 'An Ecological Study of the Genus Talinum,' *Bulletin Torrey Bot. Club*, XXIV., p. 182.

Holzinger, J. M., 'The Geographical Distribution of the Teretifolium Group of Talinum,' *Asa Gray Bulletin*, VIII., p. 36.

One fact is proved abundantly by a study of the flora of the serpentine barrens, and that is that the chemical character of the soil derived from a disintegration of the serpentine plays an unimportant part in the distribution of the plants mentioned. The distribution of such species is due rather to the physical conditions of the soil, especially with reference to water conductivity and water storage capacity (edaphic conditions). The variation in the character of the plant associations described above is in the main due to the character of the soil. If the soil is present as a well-marked surface layer, then tree associations are found; if on the other hand the rock is exposed, herbaceous associations are the rule. The surface layers of serpentine rock are broken by weathering into angular fragments, which, lying loosely together, permit the percolation of the rain water down into the seams of the underlying rock. Such exposures, therefore, support plants that have adapted themselves to living in dry situations and have structural arrangements which prevent a rapid loss of water.

JOHN W. HARSHBERGER.
UNIVERSITY OF PENNSYLVANIA.

THE AMOUNTS OF READILY WATER SOLUBLE SALTS FOUND IN SOILS UNDER FIELD CONDITIONS.

IN the investigations of the Division of Soil Management, in the Bureau of Soils, relating to the influence of soil moisture in crop production it has been found essential to take into consideration not only the varying amounts of available moisture in the soil but also the readily water soluble salts which this moisture carries in solution.

The sensitive and rapid methods which have been devised or adapted for this work enable us to determine the K, Ca, Mg, NO_3, HPO_4, SO_4, Cl, HCO_3 and SiO_2 in the soil with an accuracy of duplication ranging usually from one to five parts per million of the dry weight of the soil examined and with rapidity such that eight men are able to complete the nine sets of determinations on twenty samples daily between 9 A.M. and 4 P.M.

As these methods are now used in our soil investigations, those for the K, Cl and HCO_3 have been devised and adapted under the direction of Dr. F. K. Cameron; that for NO_3 by A. R. Whitson of Wisconsin and the writer; that for HPO_4 and SiO_2 by Dr. Oswald Schreiner; those for Ca and Mg by Dr. Schreiner and W. S. Ferris, and that for SO_4 by J. O. Belz. The clear soil solutions for examination are obtained by using the effective filter devised by Dr. Lyman Briggs.

After extended observations it has been found that to recover the maximum amount of the readily water soluble salts which are present in the soil it is necessary to first render the sample water free by drying at a temperature of 110° to 120° C., as soils are dried for moisture determinations. Mr. J. O. Belz and the writer found, for example, that after ten times washing 50 grams of a coarse, clean sand containing 4.125 mg. of potassium nitrate, that the same sample oven dried after having been ten times washed in 100 c.c. of distilled water yielded when worked in the disulphonic acid a large additional amount of nitrates. Our actual figures are given below, where from 50 grams of sand we recovered:

By 1st washing of three minutes....	3.12100 mg.
" 2d " " " "	.32840 "
" 3d " " " "	.04515 "
" 4th " " " "	.01736 "
" 5th " " " "	.01380 "
" 6th " " " "	.01280 "
" 7th " " " "	.01109 "
" 8th " " " "	.01100 "
" 9th " " " "	.01100 "
" 10th " " " "	.01101 "
After drying........................	.76290 "
Total recovered....................	4.34551 "
Amount present	4.12500 "

These observations were made in February, 1902. Later in the season, in September, we made an examination of thirty-two samples of soil, representing eight soil types, determining the amounts of NO_3, SO_4, HPO_4, HCO_3, Cl and SiO_2 which could be recovered by washing 100 grams three minutes in 500 c.c. of distilled water as they came fresh from the field, and again by washing in the same manner 100 grams of the water free sample direct from the oven.

As an average of the thirty-two determinations of NO_3, SO_4, HPO_4 and SiO_3 made by Mr. Belz, and of the Cl and HCO_3 made by Mr. A. T. Strahorn, it was found that from the oven dried samples we received 68.85 per cent. more NO_3, 62.38 per cent. more HCO_3, 62.42 per cent. more HPO_4, 244.32 per cent. more SO_4 and 287.9 per cent. more SiO_3 than from the fresh field sample, but about the same amount of chlorine in each set of determinations.

This year, early in June, Dr. Schreiner and Mr. Ferris, of this Division, have shown by a less extended series of observations that the oven-dried samples yielded 54.15 per cent. more calcium and 109.03 per cent. more magnesia.

We were led to make these observations on account of the great difficulty in determining the true amount of nitrates in soil samples, on account of the rapid changes in nitrates which occur after a soil sample has been taken, the work being done to ascertain whether it would be admissible to render the samples water free to stop such action, and were surprised to find that we could recover from the oven-dried samples more readily water soluble salts of nearly every sort determined than we could recover from the fresh sample. The reasons for this increased amount are discussed in a section of the report of our results for 1902 not yet published. In this discussion we assigned several causes, but regard the physical conditions produced by the drying as the chief one. It appears to be demonstrated that the strength of the soil solutions in the water films surrounding the soil grains increases as the surface of the soil grain is approached, in an undetermined ratio; and when a moist field sample is put into distilled water and shaken for three minutes the films of water which the soil grains and granules possess under the field conditions move about in the solution with the soil grains, and during the three minutes of agitation, which we have adopted as our practicable limit, only a portion of the salts diffuse out into the surrounding water; but when the soil sample is rendered water free the readily water soluble salts are deposited on the surface of the soil grains and the surface of the soil granules, so that when the distilled water is dashed upon them they go into solution; during the vigorous agitation, they are carried bodily away from the soil grains much more completely during the three minutes than is possible by the slower process of diffusion which must occur in the case of the moist sample, and on this account we recover a larger per cent. of the readily water-soluble salts which the soils carry.

There is still another physical condition which makes it possible to recover a large amount of readily water soluble salts by washing the oven-dried sample. In the first place the soil granules are more completely broken down by the pestling to which the samples are subjected after being oven-dried, so that the deposited salts are more freely exposed to the water when it is put upon the samples, and are dissolved more quickly on this account. Further than this, while soil samples are drying in the oven the capillary action which is set up in the interior of the soil granules brings out upon their surface a considerable quantity of the salts, which in the moist condition are retained in the interior of the granules where the diffusion outward would be necessarily slower than if the granular condition did not exist and the salts were all in the water film surrounding the surface of the compound grain. This capillary action therefore which takes place during the time of drying, brings soluble salts where the water comes quickly in contact with them, even though the pestling does not completely break down the granular structure, which, as a matter of fact, it never does.

Large as are the amounts of readily water-soluble salts which we are recovering from our field samples, observations which we cite indicate that the amounts actually present are an undertermined amount greater than those we have found. As an example of the amounts of readily water-soluble salts which field soils carry, and as an illustration of the rapidity of securing results and the character of the results, the following table is given,

TABLE SHOWING THE AMOUNTS OF READILY WATER SOLUBLE SALTS FOUND IN THE JANESVILLE LOAM, NEAR JANESVILLE, WISCONSIN, MAY 1, 1903.

	K.	Ca.	Mg.	No_3.	HPO_4.	SO_4.	HCO_3.	Cl.	SiO_2.
	In parts per million of dry soil.								
	Surface Foot.								
Nothing added	28.72	138.00	42.28	36.32	37.60	222.50	64.00	2.00	35.11
5 tons per acre stable manure	27.70	120.00	43.90	28.56	43.00	240.00	40.00	2.00	62.86
10 " " " " "	26.80	127.50	38.90	34.56	82.00	187.50	60.00	2.00	55.72
15 " " " " "	18.08	135.00	39.36	32.64	27.80	210.00	54.00	2.00	41.75
300 pounds guano	26.20	114.00	38.44	25.96	26.20	215.00	28.00	6.00	27.94
	Second Foot.								
Nothing added	48.80	96.00	34.24	46.88	18.40	178.00	6.00	2.00	68.14
5 tons per acre stable manure	24.16	100.00	36.42	24.24	19.00	185.00	12.00	2.00	68.75
10 " " " " "	31.52	66.00	36.04	28.56	34.80	162.50	22.00	2.00	63.78
15 " " " " "	27.84	86.00	32.64	28.00	24.40	200.00	22.00	2.00	28.13
300 pounds guano	28.72	94.00	34.24	23.44	8.60	200.00	24.00	2.00	36.43
	Third Foot.								
Nothing added	13.36	56.25	33.94	45.44	29.40	215.00	6.00	2.00	36.28
5 tons per acre stable manure	41.92	57.00	30.58	26.72	31.60	182.50	22.00	2.00	35.10
10 " " " " "	15.76	60.00	27.40	28.00	34.00	162.50	22.00	2.00	72.94
15 " " " " "	25.68	72.00	30.84	25.96	9.80	197.50	42.00	2.00	47.03
300 pounds guano	34.88	61.00	33.64	13.52	34.40	187.50	22.00	2.00	42.68
	Fourth Foot.								
Nothing added	27.84	53.00	33.28	42.72	17.20	195.00	12.00	2.00	26.38
5 tons per acre stable manure	26.01	51.00	26.34	30.88	72.40	190.00	14.00	2.00	39.27
10 " " " " "	29.12	57.00	26.74	26.40	56.40	160.00	12.00	2.00	87.53
15 " " " " "	28.40	58.00	25.18	25.04	28.40	167.50	12.00	2.00	56.34
300 pounds guano	18.56	55.00	30.58	20.16	80.60	215.00	14.00	2.00	25.80

illustrating a single day's work on a set of samples taken from the surface four feet.

It is not, of course, affirmed that the amounts of the different ingredients found in the soils examined are actually in solution in the soil moisture as the sample comes from the field, although in my judgment the observations indicate that this is likely to be the case for most of the ingredients at least, but observations sufficiently demonstrative have not yet been made to warrant such a statement as fact. The five sets of determinations in each group are, in a way, made on duplicate field samples; that is, they are taken at the same time from the same field but from alternating plots, one of which, as the table indicates, has received no treatment, the others having received the amounts of stable manure indicated, or the amount of guano. These samples were taken early in the spring, only a few days after the application of the stable manure and fertilizers.

Observations similiar to these are being carried through the growing season on eight types of soil in four different states, the samples being taken simultaneously in the four different localities. All of the different fields are under the same crop conditions, so that any differences in yield may be determined for comparison with the amounts of soil moisture and the amounts of readily water-soluble salts which the soils upon which the crops are growing are found to contain. F. H. KING.

BUREAU OF SOILS.
July 30, 1903.

CURRENT NOTES ON METEOROLOGY.

PRELIMINARY METEOROLOGICAL OBSERVATIONS FROM THE 'DISCOVERY' EXPEDITION.

DR. H. R. MILL, in *Symons's Meteorological Magazine* for May, publishes some preliminary results of the meteorological observations taken on the British Antarctic Expedition near Mt. Erebus. The *Discovery* was in winter quarters in a sheltered position twenty-one miles from Mt. Erebus, in lat. 77° 49′ S., long. 166° E. Among the observations three facts are of special interest by reason of their bearing upon the theory of the general circulation of the atmosphere, which is just now much in debate. Lieut. Royds, in charge of the meteorological observations, reports that

'northerly winds seem most prevalent during the summer months, and I do not think they were ever recorded in winter.' Another point concerns the direction of the upper currents, which was determined by watching the drift of the smoke from Mt. Erebus. It appeared, from these observations, that the upper winds were usually southwesterly or westerly, *i. e.*, they showed a marked tendency to blow out from the circumpolar region. A third characteristic phenomenon noted was the decided rise in temperature during southerly 'blizzards' in midwinter; a fall in temperature coming with a change in the wind direction to the eastward. As Dr. Mill points out, this rise in temperature should not be taken as an indication of higher temperatures farther south, but rather as a *fœhn* effect, resulting from the mechanical warming of descending air currents.

SCINTILLATION OF STARS AND WEATHER CONDITIONS.

Some attention has of late years been paid to the scintillation of the stars, especially from the point of view of the bearing of this scintillation upon the upper air currents. A recent study of these scintillations by Rosenthal, of the Central Observatory of St. Nicholas at St. Petersburg (*Meteorolog. Zeitsch.*, XX., 1893, 145–156), is directed towards the relation which these 'twinklings' have to weather conditions. As the basis for the investigation the writer takes the numbers (1 to 5) which indicate the quality of the seeing as noted in the observations of double stars through a refracting telescope at Domkino, 130 kilometers south of St. Petersburg, and at St. Petersburg. The observations were made on 142 evenings, from September, 1894, to November, 1900, and usually at about 9 o'clock. It appears that the least good seeing is noted on evenings with cyclonic conditions, while the best seeing is under neutral weather types. The relation of the seeing and the weather conditions has been so carefully determined by Rosenthal that he has been able to tabulate the probable seeing under a large number of different weather types at Domkino. It appears that the curve of the isobars is an important determining factor in this problem. The investigation is an interesting one, and is likely to lead to similar detailed studies elsewhere.

THUNDERSTORMS OVER MOUNTAINS AND LOWLANDS.

In the *Meteorologische Zeitschrift* for May, Hegyfoky points out that his observations of thunderstorms, carried on for a number of years in Hungary, show an earlier occurrence in mountainous districts than over lowlands. In mountains the maximum hours of occurrence were 11 A.M.–2 P.M., while, over the lowlands the period of maximum was 2–5 P.M. The studies of Héjas, on the thunderstorms of 1871–1895, in Hungary, brought out similar facts.

R. DeC. Ward.

THE BRAIN OF PROFESSOR LABORDE.

Professor Papillault* has published preliminary notes on the brain of the late Professor Laborde, the eminent French physiologist and anthropologist. The brain-weight was low, 1,234 gms., but whether this was due to atrophy from old age (seventy-three years) or disease is not stated. Dr. Laborde's notable powers of speech led Papillault to examine the subfrontal gyres of the two sides with especial care, and he found that the area in question was demonstrably larger and more differentiated on the left side (where the motor speech-centers lie in right-handed persons) than on the right. The same feature characterized the brain of Gambetta. Unfortunately, Papillault makes no mention of the degree of development of the left insula as compared with the right, for it is this region which is most concerned with the association of the receptive and emissary centers of the cortex and so constitutes the true psychic speech-center.

Papillault adds that, in general, the convolutions show an average degree of complexity.

E. A. Spitzka.

* *Rev. de l'Ecole d'Anthropol.*, 1903, p. 142.

RADIUM.

THE London *Times* publishes a report of a paper which M. Curie has communicated to the French Physical Society. It appears that at the time of his lecture at the Royal Institution in June, the resources of that laboratory in producing and manipulating liquid gases were utilized in a new series of experiments. Professor Dewar had already in 1893 improved the calorimetric use of liquid gases by means of a combination of vacuum vessels so that heat-evolution at the temperature of boiling liquid air or hydrogen could be determined with accuracy. When a sample of radium bromide weighing 0.7 gramme was tested in this way it was found to be capable of volatilizing an amount of liquid oxygen and hydrogen equivalent respectively to 6 c.c. and 73 c.c. of the gases measured at the ordinary temperature. It seems that through a very wide range of temperature the thermal emission remains unchanged. Whether at the temperature of a summer day or at that of liquid air, the emission of heat goes on without perceptible variation.

When, however, we make a long downward stride from liquid air to liquid hydrogen, radium shows that it is not always unaffected by external temperature. Within a comparatively short distance of the absolute zero a change occurs in the rate of heat-emission, but not in the direction that might be anticipated in view of the effect of low temperatures on ordinary chemical action. Instead of being reduced, the emission of heat, so far as present *data* can be relied on, is augmented at the temperature of liquid hydrogen. Whatever be the nature of this extraordinary phenomenon, it only increases in intensity at a point where all but the most powerful chemical affinities are in abeyance. The evaporation of a liquid gas gives an absolute measurement of the amount of heat given off by radium. Changes in the degree of radio-activity may escape the most careful observer, or may be imagined where they do not exist, but the quantity of liquid hydrogen which a given mass of radium converts into gas in a given time can be easily measured with an accuracy which is beyond cavil, and the amount of heat required for the conversion can be ascertained with great precision. Hence there is no longer any doubt either of the quantity of heat evolved by radium or of the fact that the rate of emission is apparently greater in liquid hydrogen than at any temperature from that of liquid air up to that of an ordinary room. At the beginning of these experiments in liquid hydrogen a contrary result appeared to emerge when the low-temperature thermal measurements were compared with the early Curie values observed at the temperature of melting ice, as formerly given in *The Times.* This led to the curious discovery that a freshly prepared salt of radium has a comparatively feeble power of giving off heat at all temperatures, but that its power steadily increases with age until about a month from its preparation, when it reaches the *maximum* activity, which it afterwards maintains apparently indefinitely. A solution of a radium salt behaves in exactly the same way. Its power of heat-emission is at first relatively low, but goes on increasing for about a month, when it becomes equal to that of the solid salt, and so remains.

MAGNETIC WORK EXECUTED BY THE U. S. COAST AND GEODETIC SURVEY BETWEEN JULY 1, 1902, AND JUNE 30, 1903.

THE work accomplished during the fiscal year, July 1, 1902, and June 30, 1903, may be summarized as follows:

A. Magnetic Survey Work.—The magnetic elements were determined at 461 stations distributed over thirty-one states and territories, three foreign countries and adjacent seas. The principal work was done in Arizona (54 stations), Florida (26), Kansas (49), Louisiana (15), Maryland (8), Michigan (14), Nebraska (19), Ohio (19), Pennsylvania (52) and Texas (72).

By December of this year, owing to the progress already made, the magnetic survey of the area bounded by latitudes 35° and 41°, and longitudes 75° and 85°, embracing the states of Pennsylvania, New Jersey, Delaware, Maryland, Virginia, West Virginia, Ohio, North

Carolina and the eastern portions of Kentucky and Tennessee, will be completed and the results at once submitted to a careful discussion, with the view of ascertaining what improvements, if any, are needed in the methods of work, to bring out all of the practical and scientific purposes of a magnetic survey.

The work in Louisiana was done in cooperation with the State Geological Survey.

B. Ocean Survey Work.—In January, 1903, a Lloyd-Creek dip circle was mounted on the Coast and Geodetic Survey Steamer *Blake* and observations made on the trip to Porto Rico and return. Some compass work has also been done by the other vessels of the survey. The work has largely been of an experimental nature as yet. It has been demonstrated, however, that if the proper precautions are taken, valuable results may be secured. The Lloyd-Creek dip circle has been proved to be a most satisfactory instrument for both land and sea work.

C. Magnetic Observatory Work.—The four magnetic observatories situated at Cheltenham (Maryland), Baldwin (Kansas), Sitka (Alaska) and near Honolulu (Hawaiian Islands) have been in continuous operation throughout the year. Owing to various improvements being made in the vertical-force instrument, only the first-named observatory is provided with such an instrument, and, in fact, at this observatory a double set of photographic instruments are in operation (Adie pattern and Eschenhagen pattern).

In February, 1903, a temporary magnetic observatory was established in Fort Isabel, Bieques Island, Porto Rico, and since March registrations of declination and horizontal intensity have been secured.

D. Special Investigations.—A variety of special investigations have been made, embracing experimental work in the field and at the observatories and theoretical investigations at the office. Thus, for example, a preliminary examination was made of the locally disturbed region in the vicinity of Machinac straits, some magnetic observations having been made on the ice during the past winter, in addition to some shore observations.

E. Expeditions.—Besides the work of the survey proper, two expeditions have been fitted out with magnetic instruments and the observers given the necessary training and furnished with the requisite data and instructions; viz., the Zeigler North Polar Expedition, W. J. Peters being in charge of the magnetic work and the Bahama Expedition of the Baltimore Geographic Society, O. L. Fassig being in charge of the magnetic work.

F. Publications.—1. 'United States Magnetic Declination Tables for 1902, and Principal Facts Relating to the Earth's Magnetism.' By L. A. Bauer, Washington, 1902. (Special Publication of which a second edition is now passing through the press.)

2. 'The Magnetic Observatories of the United States Coast and Geodetic Survey in Operation on July 1, 1902.' By L. A. Bauer and J. A. Fleming. Appendix 5, Report of the Superintendent (O. H. Tittmann) of U. S. Coast and Geodetic Survey for 1902.

3. 'Magnetic Dip and Intensity Observations, January, 1897, to June 30, 1902, by D. L. Hazard.' Appendix 6, Report of the Superintendent (O. H. Tittmann) of the Coast and Geodetic Survey for 1902.

4. 'Results of International Magnetic Observations made during the Total Solar Eclipse of May 18, 1901, including Results obtained during Previous Total Solar Eclipses.' By L. A. Bauer. Published in *Terrestrial Magnetism,* December, 1902.

SCIENTIFIC NOTES AND NEWS.

Dr. E. B. Wilson, professor of zoology at Columbia University, has been elected a member of the Accademia dei Lincei, Rome.

Captain R. E. Peary has obtained three years' leave of absence from the Navy Department, with a view to conducting another Arctic expedition. It is reported that Mr. Morris K. Jesup is taking an interest in securing the funds required, which are estimated at from $200,000 to $250,000.

Mr. Adolf F. Bandelier and Mrs. Bandelier arrived in New York on September 1, after an absence of eleven years in Peru and Bolivia. Mr. Bandelier was sent to South America by

the late Mr. Henry Villard to carry on archeological work, and was later in the employ of the American Museum of Natural History. The extensive archeological collections from Peru and Bolivia in the museum are largely the result of his industry.

DR. WILLIAM J. HOLLAND, director of the Carnegie Museum of Pittsburg, has returned to the United States with the important paleontological collections of Baron de Briet, the acquisition of which by the Carnegie Museum we were recently able to announce.

PROFESSOR HENRY F. OSBORN, of Columbia University and the American Museum of Natural History, has been visiting the camps in Wyoming and elsewhere, where paleontological excavations are in progress for the American Museum.

DR. ROBERT KOCH has secured further leave of absence in order to continue his work in Bulawayo until January next.

DR. W. G. TIGHT, president of the University of New Mexico, and Miss Annie Peck, with two Swiss guides, are reported by the daily papers to have ascended Mount Sorata in Bolivia, one of the highest peaks of the Andes, said not to have been hitherto ascended.

The American Geologist states that Dr. Ralph Arnold, assistant in geology at Stanford University, has been appointed assistant to Dr. Dall, of the U. S. Geological Survey.

DR. J. F. BIEHM has been appointed assistant bacteriologist in the Chicago Department of Health.

MR. S. R. BURCH, chief clerk of the Bureau of Animal Industry, has been appointed chief clerk of the Department of Agriculture, succeeding Mr. Andrew Geddes.

DR. WILLIAM A. WHITE, of the Binghamton State Hospital of New York, has been appointed superintendent of the Government Hospital for the Insane at Washington, succeeding the late Dr. Alonzo B. Richardson.

MR. R. FOX SYMONS has been appointed inspector general of health for the Transvaal.

THE Enno Sands prize medal for 1903 has been awarded by the Association of Medical Surgeons of the United States to Major Frederick Smith of the British Royal Army Medical Corps.

A TABLET in honor of the eminent anatomist, Xavier Bichat, has been erected in the college at Xanthua which he attended.

PROFESSOR W. H. CORFIELD, who held the chair of hygiene in University College, London, and was well known for his contributions to sanitary subjects, died on August 26, at the age of fifty-nine years.

DR. SIMON SUBIC, associate professor of physics at the University of Gratz, died on July 27, at the age of seventy-three years.

THE Iron and Steel Institute of Great Britain, which closed its autumn meeting at Barrow-in-Furnace on September 3, has accepted an invitation to meet in the United States in the autumn of next year.

FOREIGN papers state that a resolution was passed at the conclusion of the recent geodetic congress at Amsterdam requesting the various nations to carry out extensive measurements of gravity from the Atlantic towards the east through the lowlands of Europe and Asia, as well as in the plateau around Thibet. A clear conception of the variations of weight and of the distribution of bulk in the crust of the earth would be gained thereby in connection with astronomical determinations of longitude and latitude.

THE Eleventh International Congress of Hygiene and Demography will be held at Brussels from September 2 to September 8, under the patronage of the King of the Belgians and the honorary presidency of Prince Albert. The president is Mr. M. E. Beco, general secretary of the ministry of agriculture; the general secretary, Dr. Felix Putzeys, professor in the medical faculty of the University of Liége.

DR. O. P. HAY has recently returned from a collecting trip in the Bridger deposits of southwestern Wyoming in the interests of the American Museum of Natural History. He spent there seven weeks, engaged especially in collecting fossil turtles, the others of the party being engaged in collecting remains of prim-

itive horses, monkeys and uintatheres. Altogether, there were secured over one hundred and thirty specimens of turtles. Some of these were more or less fragmentary, but there were found many complete shells and, in addition, seven skulls. These specimens will serve to throw light on the Eocene turtles, since many of the species were originally based on defective materials. Hitherto, skulls of the Bridger species have been almost wholly unknown. Of interesting genera whose skulls were obtained this summer may be mentioned *Baëna* and *Plastomenus*. The materials which were secured are to be employed in the preparation of a monograph of the fossil turtles of North America, for the Carnegie Institution.

The expedition which left Seattle on June 30, on the Fish Commission steamer *Albatross* to investigate the salmon fisheries of Alaska is expected to return on the fifteenth of the present month. President David Starr Jordan, head of the commission, returned to Stanford University some time since. Among other members of Stanford University on the expedition were Messrs. C. H. Gilbert, Harold Heath, H. M. Spaulding and D. R. Rutter.

The Canadian government steamer *Neptune* sailed on August 22 from Halifax for Hudson Bay and Arctic waters on an expedition lasting a year and a half with a view to botanical, geological and natural history investigations. The party will take formal possession of the Arctic Islands and the shore of Baffin's Bay.

It is announced that the relief ship *Frithjof*, of the Swedish Antarctic Expedition, will be fitted with wireless telegraphy in order that it may remain in communication with gunboat *Uruguay* sent by the Argentine government. Baron Klinchowström accompanies the relief expedition as zoologist.

Mr. Andrew Carnegie has under the usual conditions offered to give £6,000 for a library building at Peterborough and £7,000 for a library building at Erith, Kent.

Mr. Edward D. Adams has given to the American Museum of Natural History a specimen of radium, which has been placed on exhibition.

Nature states that a general exhibition arranged by the Central Association of Inventors, of Bayreuth, for the purpose of facilitating the sale of patents and copyrighted patterns is to be held during September and October next at Nüremberg. There are, it is stated, more than 200,000 copyrighted patterns in Germany and more than 140,000 patents, but one half of these are not in public use, the reason being that the inventors are not able to exploit their inventions. It was because of this that the Central Association came into being some years ago. Its purpose is to assist the members to make their inventions profitable to themselves, the majority of inventors not having the means to do so. The association furnishes space to inventors without means free of cost, and charges no fees for effecting a sale.

The British Medical Journal states that in the Germanic Museum at Nüremberg there has recently been placed a large medico-historical collection of medals. A considerable number of them were purchased at a sale held not long ago at Amsterdam.

According to the *Journal of the American Medical Association* the Germans are planning to make an elaborate exhibit at the St. Louis Exposition of everything connected with medical instruction, especially in respect to diagnostics and therapeutics. Professor v. Bergmann is in charge of the matter, assisted by a committee, which includes Drs. Kutner, Kraus, Mikulicz, Orth, Rubner, Waldeyer, Wassermann and others, nearly all of Berlin. A circular inviting cooperation is to be sent forthwith to all the prominent institutes and firms throughout Germany.

A press despatch from Simla, India, states that the Irrigation Commission has issued its report. It proposes to lay out $150,000,000 in twenty years on protective works, and also $2,000,000 annually in loans for private irrigation works, the necessary funds to be raised by loans, and the interest thereon to be charged to the famine grant.

On the initiative of the director of the St. Petersburg Institute of Experimental Medi-

cine a Russian Microbiological Society is being organized.

Sir Thomas Hanbury has purchased and presented to the Royal Horticultural Society the estate and garden of the late Mr. G. F. Wilson, F.R.S., at Wisley, near Woking.

We quoted from the London *Times* some time since a statement that Sir William and Lady Huggins had contributed a paper to the Royal Society not then published containing the announcement of the discovery of lines of helium in the light emitted by radium. It was discovered subsequently that the lines were of nitrogen, and this result was added to the paper before publication. Sir Michael Foster thus explains the matter in the London *Times*. In mid July, during the recess, the Royal Society received (the officially recorded date is July 17) from the President, Sir W. Huggins, a short communication stating that by long exposure he had been able to obtain from the glow of radium at the ordinary temperature a photographic record of bright lines in the blue, violet and ultra-violet regions of the spectrum, and that several of these lines coincided with those of helium, but not with the most characteristic ones. A paper of such importance was sent at once to the society's printers with a view to its being published as early as possible. Within a few days, however, continued observations convinced Sir W. Huggins that the lines in question were those not of helium, but of nitrogen. Having arrived at this conclusion, he might have wished to withdraw the paper which he had sent in, replacing it by a wholly new one. He preferred to let the former paper stand as written, and to communicate the new results in the form of a dated addendum. The addition was printed as received on August 5, and the whole paper was published on August 15. In pursuing this course, the president followed the usual customs of the society, and, in my humble opinion, chose the better way, since a knowledge of the several steps through which an important result is reached is second only in value to the knowledge of the result itself. And, had the matter been confined within the publications of the society, nothing could have been said. But a friend of Sir W. Huggins, who saw the first part of the paper before it was officially received at the society, struck with its great importance, and knowing the willingness with which you, Sir, to the great benefit of the public, publish in your columns early notices of striking scientific discoveries, sent you a communication on the subject which you were good enough to print. 'Inquirer' complains that no similar communication concerning the notable addition to the first part of the paper has appeared. May I venture to point out that, in the absence of any organized arrangements, gaps, such as the above, in the scientific information which you publish are for one reason or another liable to occur without anybody being to blame?

Some rare lizards have been deposited by Mr. Walter Rothschild, in the London Zoological Garden. According to the London *Times* his specimens of the Cuban anolis (*Anolis equestris*) are the first received alive in Great Britain, though the species has been known for nearly 200 years. Sir Hans Sloane was the first to describe it, from specimens obtained in Jamaica, and he compared it to a small iguana with a short comb or crest on the back, and a very long tail. The general color of the upper surface is bluish green, and of the under surface pale green—a color-scheme which is no doubt protective, and a later observer says that the reptile is scarcely distinguishable among the foliage of the trees on which it lives. The throat-pouch is of a deep pink, and, when inflated, gives the animal a very striking appearance. In the same cage is a chameleon lizard (*Chamæleolis chamæleontides*), from Cuba, also exhibited for the first time. As one would imagine, from the scientific names, there is a superficial resemblance to the chameleon; this is very strongly marked in the head and in the shagreen-like tubercles covering the body. The general hue is ashy brown, with rufous markings, and the throat-pouch is tinged with purple. The arrival of this specimen removes the doubt expressed by some writers as to whether the loose skin of

the throat could be inflated, for it is distended whenever the animal is excited. Late last year the scale-footed lizard (*Pygopus lepidopus*) was represented for the first time in the collection. Other specimens have recently been put out. In some respects these limbless lizards from the Australian region have a general resemblance to the British slow-worm, but the tail is exceedingly long and tapering, and the hind limbs are represented by two scale-like flaps of skin, closely adpressed to the side. These can be moved at will and contain the vestiges of the toe bones, which can be felt between the finger and thumb. In the sloths' house is an example of the Australian spiny anteater (*Echidna aculeata*), with the exception of the duck-billed platypus the lowliest of all mammals. It may be compared in appearance to a hedgehog, with long, strong spines and a beak-like snout about as long as that of the platypus, but tubular in shape. Its popular name is correct, so far as regards its food, which is obtained by the protrusion of the worm-like tongue, as is the case with the great anteater (*Myrmecophaga jubata*) of South America, examples of which are in the same house. There is, however, no close relationship, the former laying eggs, and having traces of a marsupial pouch, while the latter is a true mammal. Many authors reckon three species of spiny anteaters, according as there is more or less hair mixed with the spines, while others attribute this difference to the effect of the climate of Tasmania and New Guinea (where the more hairy forms occur) and claim that the examination of a large series of skins shows that the extremes grade into each other.

English papers state that steps have been taken to begin immediately the construction of the section of the Cape-to-Cairo Railway between Wankie and the Zambesi at Victoria Falls and that 2,500 laborers will at once commence work on this section. Railhead will be at Wankie, about 200 miles northwest of Bulawayo, very shortly. With regard to other railways in Rhodesia, on the branch line between Bulawayo and Gwanda 31½ miles of rail have been laid of a total length of 104 miles. The Selukwe line will be finished at an early date, as the rails have already reached a point 16 miles from Gwelo and sufficient material is now on the spot for the completion of the branch. The removal of the light rails on the Vryburg-Mafeking section is rapidly proceeding, and, according to the latest advices, 42 miles out of the total 96 had been relaid with 60-pound rails.

UNIVERSITY AND EDUCATIONAL NEWS.

The Imperial Chinese University at Pekin which abandoned its attempt to introduce European learning under the retrograde policy of the Dowager Empress has now been closed.

Professor J. Mark Baldwin, of Princeton University, has been called to a new chair in philosophy and psychology in the Johns Hopkins University, where it is proposed to organize a university department in these subjects. Professor Baldwin will immediately enter upon his new duties, but it is expected that he will also give during the coming term certain senior and graduate courses at Princeton, where he may be addressed.

Dr. E. W. Scripture, assistant professor of experimental psychology at Yale University, has resigned and is succeeded by Dr. Charles H. Judd, A.B. (Wesleyan), Ph.D. (Leipzig). Dr. Scripture is spending the year at Leipzig, where he is carrying on researches on the analysis of speech by means of gramophone records under the auspices of the Carnegie Institution.

Dr. John G. Curtis, professor of physiology at the College of Physicians and Surgeons of Columbia University, has been elected acting dean of the college.

Dr. Augustus Pohlman has been appointed assistant professor of anatomy at the Johns Hopkins University.

At Leland Stanford Junior University, Dr. Edward C. Franklin, of the University of Kansas, has been appointed associate professor of organic chemistry, and Dr. J. R. Slonaker, of the University of Chicago, has been appointed assistant professor of physiology.

M. Leboeuf has been appointed professor of astronomy at the University of Besançon.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*WHAT TRAINING IN PHYSIOLOGY AND HYGIENE MAY WE REASONABLY EXPECT OF THE PUBLIC SCHOOLS.**

IN the public schools of to-day various subjects are taught, and for various reasons. Some, like arithmetic or the reading and writing of English, are indispensable tools of modern civilized life; others, like geography and history, impart necessary information or promote general intelligence; still others, like algebra, geometry and Latin, are agents of mental discipline or else afford necessary preparation for subsequent work. Physiology and hygiene, the studies with which we are concerned in the present paper, were introduced into the public schools for the express purpose of affording information concerning the structure and functions of the human body, being expected thereby to contribute to the preservation and promotion of health; and they have kept their place, in spite of serious shortcomings, as a concession to the practical importance of sound ideas concerning health and disease.

The training which may reasonably be expected in the reading and writing of English, in arithmetic, in geography or in Latin, is the subject of frequent discussion in educational gatherings and is doubtless influenced by such discussions: but it is determined chiefly by the exami-

* Read before the American Social Science Association, Boston meeting, May, 1903.

nation requirements of the upper grades and by the entrance requirements of higher educational institutions. With physiology and hygiene the case is different. Proficiency in these is rarely made a condition of promotion. They are seldom included in the list of requirements for admission to colleges or technical schools, and never in those for medical schools. They are not often much considered in educational congresses. And yet it is doubtful whether any subject in the whole curriculum of the public schools is of greater intrinsic importance as a preparation for life, or is capable of affecting more profoundly the whole mental attitude of men and women toward an enduring and well-organized civilization.

The real importance of physiology and hygiene is unquestionably far greater today than it was twenty-five years ago. At that time physiology was a new science. It was still commonly taught in medical schools as an adjunct to anatomy, and the double-headed professorship of anatomy and physiology had not then become extinct. As for hygiene, this was largely a body of precepts based upon *a priori* reasoning, or else of deductions derived jointly from anatomical knowledge, common experience and common sense. Disease was only a little more baffling that health, and the promotion of one poorly understood condition by the prevention of one still less comprehended was not only a most unsatisfactory, but a most unscientific undertaking. Nevertheless, in spite of this difficulty and uncertainty, physiology and hygiene, such as they were, have steadfastly held their place in the curriculum of the public schools, no doubt because of an unconquerable belief that they should somehow furnish to the developing mind and the forming character some real and lasting help in the preparation for life.

And at last this belief seems likely to bear fruit and to justify its long and patient expectation. For to-day physiology has won an established and recognized position as an independent science. It has become entirely separated from anatomy. It has its own professors in our medical schools and universities. We have a strong and active American Physiological Society, composed of expert investigators and teachers, and a flourishing *American Journal of Physiology,* which publishes regularly budgets of important discoveries.

In hygiene the progress has been even more remarkable. Twenty years ago the infectious diseases were as mysterious as ever, but to-day we understand the essentials of their operation and also to a great extent the mechanism of their dissemination and, therefore, in many cases the ways of their prevention. The clouds of mystery which until lately hung about them have been largely cleared away, and a new hygiene, based partly upon experimental physiology and partly upon experimental medicine, has come into being. Meantime an enlightened sanitary engineering is building improved sewers and water-works and dealing with the purification of sewage and water, with the construction of sanitary pavements, with the dust nuisance and with efficient scavenging and garbage destruction. Boards of health are equipped with laboratories for sanitary testing and research. They are supervising the medical inspection of schools. They are isolating cases of infectious disease and securing the disinfection of clothing and of houses. They are enforcing vaccination. They are vacating unwholesome dwellings.

Educators themselves are engaged in hygienic endeavors. They are providing for playgrounds. They are beginning to attend as never before to the ventilation of school buildings. They are interested in the lighting of school-rooms, in the seat-

ing of the pupils, and in their sight and hearing. The home also is receiving the attention of hygienists. Its site, its drainage, its wall papers, its ventilation, its cookery, are undergoing careful investigation.

And, finally, personal hygiene—the care of the individual body, its exercise, its fatigue, its work, its rest, its play, its clothing, its bathing, its hunger and thirst and sleep, its growth and its old age—is being dealt with to-day, not superficially and by tradition or experience alone, as formerly, but also by experiment. Physiology and hygiene have become experimental sciences, and have thus taken on a new and higher value. In view of all these marvelous changes, we may properly ask and undertake to answer the question which forms the subject of this paper.

But first and always we must keep steadfastly in mind the end and object sought for in the training under consideration. This has always been and still is primarily practical and technical, namely, a sound preparation for the right conduct of physical life. For although it is one argument for increasing the efficiency of instruction in these subjects that they give information on matters of great human interest, and that, when rightly taught, they are of high educational value, still the primary purpose of teaching them is not to give information nor mental discipline, but because their subject matter is of immediate and enduring importance in determining and promoting the right conduct of the physical life, and especially the preservation and promotion of health. Their value is special rather than general, practical rather than cultural, technical rather than disciplinary.

We may confess frankly that physiology and hygiene have not always hitherto justified their place in the curriculum by their results. It would be going too far to deny that they have been without influence, or that in exceptional cases they have not been valuable; but they certainly have not, on the whole, accomplished what was originally expected of them. Their results have been disappointing, and it is by no means unusual to hear competent educators express the opinion that it would be better to drop them altogether. Physiology and hygiene are too frequently looked upon by school authorities as an unavoidable necessity, and by teachers and pupils as a bore. And yet we doubt whether any of these superintendents or teachers would care to take the responsibility of banishing them altogether from the curriculum. They may not be a success; but the conviction remains that they ought to be a success, and doubtless the hope, however faint, that some day they will be.

The present unfortunate condition of affairs is due, in our opinion, largely to the fact that the primary purpose of these subjects in the curriculum has been neglected or forgotten. They were perhaps introduced prematurely, as has been suggested above. Fifty years ago anatomy was the one branch of medical science about which definite statements could be made, but little was known about physiology, and the great field of hygiene was largely a matter of either popular tradition or impressions derived from personal or racial experience, often, indeed, surprisingly accurate, but nevertheless lacking in the certainty of experimentally demonstrated fact.

It is only exact knowledge which lends itself to school instruction. We do not teach electricity in our courses in physics by speculating about thunderbolts or the nature of magnetism, but by telling what we know of the production, the conduction or the induction of electrical energy. We leave the region of the indefinite to the investigator. It is easy to see, therefore, how it came

about at the outset that in planning the work in physiology and hygiene in schools the details of gross and minute anatomy should have formed the major part of the whole. Function was treated but sparingly, because very little was known about it; and considerations of health and disease occupied an insignificant place simply because definite statements could not possibly be made about them. The instruction in school physiology and hygiene was chiefly anatomical for the reason that the dissecting room was the sole laboratory of the medical school. It was the one region of real and accurate knowledge of the subject.

We have said above that this condition of hygienic knowledge has been entirely transformed during the last twenty years. The physician is far less mysterious in his manner than formerly, because his fund of knowledge is vastly greater. He often explains his reasons to his patient and discusses the facts of his profession with 'the laity,' where he would not have done so fifty years ago. It was within twenty years that one of our leading pathologists was heard to define malaria by remarking, 'When you don't know what it is, it is malaria.' To-day he would not give that definition, but would delight to describe the wonderful story of those discoveries which within a score of years have led to our present satisfactory understanding of the nature and mode of dissemination of this disease.

The teaching of physiology and hygiene in the public schools has lagged far behind this march of medical and hygienic progress. It is inexcusably behind the times. We now have facts which any one can teach and which should be made known as a preparation for the proper conduct of life; and it is these facts which should form the main part of the teaching. The subject matter should be thoroughly revised, and in no more important particular than in the restriction of anatomy to the minimum amount needed to give a clear conception to the general structure of the body as a mechanism and of the normal working of that mechanism. In a rural school-house on the Maine coast we once saw upon the blackboard, painfully written down by a fisherman's child, a long and learned list of the bones found in the human body. Even for a medical student the list, as such, apart from the physiology and surgery of the bones, would have been of small value; for the children of fishermen, the bones of the cod or haddock or of the domestic animals would probably have been of greater consequence. An arid osteology is a poor introduction to the study of modern hygiene, and one not calculated to arouse a compelling interest in the subject.

Similar considerations hold with regard to the teaching of physiology. The educational value of this science, it is true, is much greater than is that of pure anatomy, for, in the first place, it is more interesting. Not only in childhood, but throughout life, we do not care greatly about the parts of a machine unless we know or can guess their use. From this point of view physiology is a good teaching subject, and all the more so because it deals with a machine in which most of us are naturally interested. The study of the activities of the human body has also the highest philosophic value. It imparts that first and most important lesson for the conduct of life—a lesson which every person leaving the upper grades of the public schools should carry away with him—that the human body has a material basis and is a *mechanism*, a *machine*. We must constantly recall, in order to emphasize, Huxley's saying that 'the distinctive feature of modern as contrasted with ancient physiology' is 'the fundamental conception of the living body as a physical mechan-

ism.' That this fact is not with most people a part of the philosophy of living is shown by the use and abuse of patent medicines and the frequent neglect of the commonest care of the body, such as would be wisely bestowed on a watch or a bicycle.

We have urged that anatomy has no place in the public school curriculum except as it is necessary to the understanding of the problems of physiology and hygiene; and we shall see it cut down to the minimum needed for this purpose without the slightest regret. We should not feel the same if physiology were similarly made strictly subservient to personal hygiene, that is, if, in doing so, its philosophical value were neglected; but, fortunately, this is not necessary. The physiology which is most useful in understanding the problems of personal hygiene is almost exactly the same body of facts which has the greatest philosophic value; and the method of presenting them is the same for the one purpose as for the other. We have not the time to enter into details in this matter, but we are speaking from experience and are sure of our ground. The instruction in physiology should aim at the outlines of the more important functions of muscular contraction, nervous activity, circulation, nutrition, temperature regulation—all of these expressed as far as possible in terms of physics and chemistry. It should endeavor to avoid needless details. For example, the pupil should understand that the heart is a force pump, but it is not necessary that he should understand the exact structure or mechanism of the auriculo-ventricular valves.

Again, physiology should not be made primarily, or even to any large extent, in public schools, a means of laboratory training. Such training can be had more readily and more advantageously in chemistry and physics. To attempt to give the same laboratory training in physiology as in these subjects would inevitably be to consume precious time which is urgently needed for hygiene. The fundamental facts of physiology can be demonstrated and enforced in the laboratory, even in common schools, without much difficulty, and we would not for a moment depreciate the value or the necessity of a certain amount of this kind of instruction; but the use of the laboratory (always time-consuming) must not be allowed to distract attention from the true function of physiology and hygiene or to interfere with its fruitful realization.

A course of moderate length in physiology should suffice to impart enough facts of structure and function to furnish a solid basis for sound training in hygiene, and to give meanwhile an abiding sense of the material composition and mechanical character of the human body and some knowledge of its environment and operation. With so much of preparation it is easy to pass on to a practical consideration of health and disease, the means of promoting the former and of avoiding the latter. Health becomes simply normal, disease abnormal, living. Such terms as 'constitution,' 'strength,' 'weakness,' 'feebleness,' 'robustness,' are easily understood by constant reference to mechanisms, well or poorly made, or to structures, strong or weak. Wounds become interference caused by invasions or damage by extraneous matters—bullets, knives, parasites, clubs, dogs, slivers—which are as obviously out of place in living mechanisms as dirt in the works of watches. Germs are microscopic invaders, microscopic parasites. They enter and wound and kill, not mysteriously, but by damaging or interfering with the human mechanism. Best of all, they can often be kept out by the avoidance of exposure, as truly as bullets can.

Passing on to the strictly hygienic part of the subject, first in logical sequence comes personal hygiene, the proper regulation of the activities of individual life—

muscular work, mental activity, feeding, the protection against colds and other inflammations, the care of the body by bathing and clothing and the like. These should not be touched upon in short paragraphs which, like after-thoughts, conclude the chapters on anatomy or physiology, but should be separately and fully treated for their own sake, and from the standpoint of the organism as a whole rather than from that of special organs. These are subjects about which every one needs real and true information, and sooner or later seeks it. Shall such knowledge be obtained from the public schools, or sought unwisely and in vain in the brazen advertisements of magazine originators of new systems of physical training, or in the rash and not often disinterested advice of advocates of new breakfast foods?

Modern hygiene begins with the individual, but deals also with the hygiene of the family, of the community, of states and of nations. In a rapid review of the place which these branches of the subject should occupy in our preparation for sound private and public life, it must not be forgotten that the great majority of the pupils in our public schools have no opportunity or intention to enter colleges or higher schools, and yet are likely to become householders, housekeepers, heads of families or citizens. The principles underlying household or domestic hygiene and sanitation therefore claim some consideration at their hands. These should include such questions as the proper site of the house, the value of fireplaces as ventilators, the importance of wall papers free from arsenic, the advantages of bare floors, and of simple rugs as compared with carpets difficult to clean, the necessity of a pure and abundant water supply, the desirability of prompt removal of wastes by drainage and by such other devices for rural communities as may be made most sanitary under the circumstances, the dangers of damp cellars with the reasons why cellar dwellings are so peculiarly unwholesome, the dangers of illuminating gas (especially the modern so-called 'water gas'), the need of careful consideration and frequent inspection of gas fixtures to avoid small but dangerous leaks, and other similar matters bearing directly or indirectly upon the welfare and sanitary condition of the home. Here might well be told the truth in regard to the advantages and dangers of cesspools and sewers, and of leaky or otherwise defective plumbing.

Place should also be found, and might easily be made by the sacrifice of some osteology and histology, for a brief consideration of the health of communities, such as thickly settled neighborhoods, growing towns or cities; of the dangers attending impure water supplies and defective sewerage systems; and the importance of methods for the sanitary removal and disposal of garbage, rubbish and the other wastes of life. Something might well be said regarding the need of proper municipal supervision of all these matters as the essential of a rational municipal sanitation and of the sanitary value of good public service. Here also might be taken up the advantages and the right use of municipal parks, playgrounds and gymnasia, of public lavatories, water-closets and washhouses; of smoke abatement and noise suppression; and something said regarding clean streets and the thoughtless scattering of papers, banana skins and the like rubbish, which necessitates a costly scavenging; something regarding pure ice and especially pure milk—problems in the solution of which all classes of the community must eventually take an active interest and participation, if reform is to come.

And, finally, room should be found for a brief explanation of quarantine, its advantages and disadvantages; the isolation of cases of infectious disease and the reason why this is so essential to the public,

though so inconvenient to the individual; the necessity for public hospitals for contagious diseases and for municipal or state sanatoria for tuberculosis; the fundamental problems of international hygiene; public food inspection, such as that conducted by the federal government for trichinosis in pork to be exported to foreign countries; and other problems calling for intelligent cooperation of the citizen in national and international hygiene.

Trained along these lines, the youth of America, whether or not afterwards going to college or technical school, would enter upon their maturer life with some realizing sense of the general structure and operation of the body as a physical mechanism, and the necessity of obedience to physical laws. They would become familiar with the sources of diseases and with some of the more obvious ways of avoiding them. They would have some intimation of their duty, not only to themselves and to any families which they might afterwards have, but also concerning wholesome houses, pure supplies, the safe disposal of wastes, and some of the problems of the municipality, and even of the nation, of which they are units.

We have, of course, to meet the important objection which will be urged against our point of view, that, desirable as all these things may be, the time available is too short for proper dealing with them. This, however, we deny. Time enough to do all these things and to do them well, either is now or lately has been found in the public schools in the various courses for instruction in physiology and hygiene. It will be necessary, it is true, to revise and bring up to date our subject matter and our methods of instruction. We must teach less about bone and sinew, and more about muscle and nerve. We must teach less about anatomy and histology, and more about the germ theory of disease, about polluted water and polluted milk. We must simplify every statement and eliminate the unimportant. We must not seek to make of physiology a training in the precision of measurements, or in scientific method, or in anatomy, or in physiological chemistry. Some experiments must be made by the students, and demonstrations by the teacher must abound; but we must keep steadily in view the practical object for which chiefly school time is, and long has been, dedicated to physiology and hygiene, namely, the rational conduct of physical life.

Above all, we must insist upon relief from the incubus of that 'scientific temperance' instruction, so called, which has too long rested upon the teaching of physiology and hygiene, winding its tentacles about it and, octopus-like, sapping its strength and crushing out its usefulness. On this subject let us have no misunderstanding. The evil effects of the use of alcoholic drinks must be fully and clearly inculcated. The youth of America must be thoroughly informed of the insidious dangers which lurk about strong drink. But, on the other hand, we must never forget that the public schools are no place for any propaganda and that the freedom of teaching must not be surrendered even to reformers.

Whether we are pleased with the fact or not, modern life has become more strenuous. In order to achieve success, the individual must do more in a given time; hence the urgent importance of a personal hygiene which shall really guide him in the proper care of the body. Meantime the care of the public health has become one of the most important functions of government, and it will be increasingly important in the future. Its success in America must largely depend upon an enlightened citizenship to which it can look for support. We now teach history and eco-

nomics and civics with some reference to the future life of the public school pupil as a citizen. Our teaching of hygiene should keep in view the same great end, and if this paper draws attention to the lamentable inadequacy of our present instruction in that subject to this purpose, our object will have been accomplished.

But much more is needed. We need a clear conception of the true place of physiology and hygiene, but we need also the proper teachers to realize that conception. If the subject is as important as we have represented, it should be taught by teachers specially trained. In the higher grades of our schools we often have special teachers of languages, of history and civics, of mathematics, of the natural sciences; but it is rare indeed to find physiology and hygiene in the hands of teachers who have had special training in these subjects. Too frequently they are imposed upon the least experienced member of the staff, whose connection with the school is too recent or whose tenure is too precarious to allow refusal. All this must be changed. The exact method of securing the trained instructor may often be left to local conditions. At times, medical examiners, the demands of whose practice are not distracting, and who are at the same time good teachers, may fill the position; at other times, teachers of the biological sciences should be encouraged to prepare themselves for the work.

A method which especially commends itself to us is to combine this work with that in physical training. The teachers of physical training, of all the instructing staff of the school, stand in closest relation to the work of preservation and promotion of sound health. At present their work is somewhat narrow and suffers from the lack of any direct explanation of the principles of physical training. It would broaden the work of these teachers and make their present efforts more effective, if physiology and hygiene so obviously related to their other work were placed in their hands. True, it would require a broader preparation and an extension of the work of our normal schools of physical training in both time and scope; but this is really an argument in its favor. Normal schools of physical training ought to extend and enrich their courses, especially in view of the fact that so many of their graduates must occupy positions in the higher grades.

There is a widespread feeling that the present training in physiology and hygiene in the public schools is a failure. But signs are not lacking of a strong feeling among prominent educators that these subjects can and should rank in dignity and usefulness with languages, mathematics, physics, chemistry, biology, history and civics. Physiologists have long protested against the domination and excesses of 'temperance physiology.' Educators have complained of the bad pedagogical requirements often placed by law upon the teaching of the subject. We appeal to the members of the American Social Science Association to aid us in bringing about a reform, not as parties to either side of a dispute on questions of scientific fact about alcohol, nor from the standpoint of pedagogic theory and practice, but because the subject is one which profoundly affects social conditions and is closely related to a more intelligent and a more successful conduct of individual and social American life.

William T. Sedgwick,
Theodore Hough.
Massachusetts Institute
of Technology.

PRELIMINARY REPORT ON THE MARINE BIOLOGICAL SURVEY WORK CARRIED ON BY THE ZOOLOGICAL DEPARTMENT OF THE UNIVERSITY OF CALIFORNIA AT SAN DIEGO.

The marine biological work of the Department of Zoology of the University of

California during the summer of 1901, with San Pedro, California, as a base of operations, was planned and carried out 'as though it were to be the beginning of a detailed biological survey of the coast of California.'*

That season dredging and trawling were the chief work. A large number of dredging stations at San Pedro, around Santa Catalina Islands and at San Diego were occupied, charted and their bearings recorded. Many hauls were made, several at each station, as far as possible. All the material secured was either preserved or in case of species so abundant as to make their preservation seriously burdensome, was recorded, quantitatively as far as practicable.

Owing to lack of funds, nothing was done during the summer of 1902 toward the survey work beyond some shore collecting at San Pedro. During the present summer the survey idea has been again foremost. It seemed this year, the total of circumstances being taken into consideration, that it would be best to devote attention to the plankton chiefly. A sail vessel could be used for this kind of work more advantageously than for dredging and trawling, and would be much cheaper and consequently would make the limited funds available go considerably farther. Two good, intelligent fishermen would be able to do nearly all the collecting alone, thus permitting the naturalists to devote their whole time to studying the material as it should be brought in. Again almost nothing had hitherto been done on the plankton of the waters of this region.

The laboratory was moved this summer from San Pedro to San Diego, or, more exactly, to Coronado. Several considerations brought about this removal. The most potent was the fact that a number of citizens of San Diego were desirous of having the work carried on there for a summer, at least, and were willing to furnish the funds to defray the expense of moving and of operating the station for six weeks during the summer and two weeks at the Christmas vacation, 1903–1904. Again, the zoologists of the university were glad of the opportunity to test more fully than had before been possible the fitness of the San Diego region as a location for a laboratory. Finally, the improvements of the harbor at San Pedro now being carried on by the national government, and the important commercial development in progress there, have made the building occupied as a laboratory inaccessible for this purpose, and have seriously, and, it is to be feared, permanently, impaired some of the most distinctive biological advantages of the location.

At Coronado ample quarters for a laboratory, well lighted and conveniently located, were generously given and partially fitted up by the Coronado Beach Company in their old boat house on Glorietta Bight. For a vessel the five- or six-ton schooner *Lura*, formerly a pilot boat of the port, was hired. This in charge of Mr. Manual Cabral, an unusually intelligent and competent fisherman, with a helper was kept constantly at the collecting, almost though not quite exclusively, of plankton.

The nets used were of Nos. 000, 12 and 20 miller's bolting. No closing net was employed, but a series of nets placed at intervals on a rope and hauled vertically was the means used to differentiate the depths at which the macroplankton was taken. For the comparatively shallow depths, not exceeding two hundred fathoms, to which the operations were limited, this method gives very good results. This is particularly true when there is but little wind or drift so that several hauls can be quickly made in nearly the same place. For collecting

* 'A Summer's Dredging on the Coast of Southern California,' Science, January 10, 1902, p. 55.

microplankton from different depths pumping was resorted to. For this a semi-rotary 'clock' force pump of one half inch intake and one half inch garden hose were used. This collecting was not extended below a little less than 100 fathoms. The volume of water that could be obtained by so small a pump and hose was too small to make the results wholly satisfactory. The trial convinced us, however, that the method is sound even for considerably greater depths than we were prepared to go, and that with a larger power pump and the right sort of a filter it would be of much importance. The most serious difficulty encountered during the summer was the lack of wind for propelling the schooner. Night collecting proved to be practically impossible most of the time on this account, and much of the time during the day the more sensitive organisms like some radiolarians, some medusæ, appendicularia, etc., were usually dead on reaching the laboratory when they were brought from a distance of six or eight miles.

The regular staff of the laboratory, *i. e.*, those engaged upon the survey work proper, with their tasks, were as follows: Wm. E. Ritter, Ph.D., professor of zoology, in charge, protochordata; C. A. Kofoid, Ph.D., assistant professor histology and embryology, protozoa; H. B. Torrey, Ph.D., instructor in zoology, cœlenterata; C. O. Esterly, A.B., assistant in zoology, copepoda; J. F. Bovard, B.S., assistant in zoology, protozoa, with Professor Kofoid; H. M. Evans, senior student in the university, hydrography and preparateur in zoology.

In addition the following persons used the laboratory for prosecuting their own special studies: Dr. A. Carlson, of the Leland Stanford Jr. University, investigations on the comparative physiology of the invertebrate heart; Mr. B. M. Davis, Los Angeles Normal School, investigations on the flotation of pelagic animals; Miss Marion Hubbard, of Wellesley College and the University of California, general studies on tunicata and mollusca; and Miss Margaret Henderson, a student of the University of California, special studies on the cœlenterates with Dr. Torrey.

SOME RESULTS.

No part of the summer's work was done with greater regularity and interest than the hydrographic, though only the temperature and the specific gravity of the water were attempted. About 150 determinations of each of these were recorded. This number is, of course, too small, particularly when confined to so limited an area and so brief a time, to have more than local significance. Even so, however, a few facts worthy of noting were brought out. It was found that the specific gravity of San Diego bay water was distinctly higher during the period of observation than that of ocean water, and that near the head of the bay it was higher than in the middle portion. The averages are: Ocean water, 1.02455+; bay water, middle portion (at Coronado), 1.02546+; upper portion (off National City), 1.02626+.

Although these results are what would be expected in view of the fact that San Diego Bay is a land-locked, comparatively shallow body of water, they are still of interest particularly because it has been surmised that a large subterranean inflow of fresh water from the San Diego River enters the bay at its upper end. While these observations do not disprove the conjecture, they obviously do not support it. Furthermore, the difference between ocean water and bay water was somewhat greater, on the average, at low tide than at high, the average differences being for low water, .001003+, and for high, .00087.

Another interesting but puzzling fact was

the sudden drop in both temperature and specific gravity of ocean water on July 27. Up to this time the average surface temperature at Coronado pier, taken at ten o'clock in the morning, had been about 20° C. On that date at the same hour of the day it was 16.2° C. This low temperature continued about three days, when the previous conditions were gradually resumed. The specific gravity fell distinctly though slightly with the temperature. These unusual temperature and density conditions were not associated with any special increase or change in direction of the wind or fall in atmospheric temperature, neither could they be with certainty correlated with any known tide or current movements.

Professor Kofoid reports as follows on the work done by him and Mr. Bovard on the protozoa:

Attention was confined almost wholly to the forms taken in the silk net on or near the 'bank' off Pt. Loma, and to a few catches nearer shore and in the bay. The plankton is very rich in the well-known pelagic groups Peridinidæ, Tintinnidæ and Radiolaria.

Of the *Peridinidæ* 59 forms were found. The list includes a number of varieties known only from the Bay of Naples, from Marseilles, the Red Sea and the Gulf of Aden, and includes many if not all of the well-known forms from the Atlantic and Mediterranean. The entire list is reported for the first time from this coast and most of them for the first time from the Pacific Ocean.

Of the *Tintinnidæ* 30 forms were observed, including several of unusual interest and importance. All of the species are listed for the first time from the Pacific Ocean, and many of them were known heretofore only from the Mediterranean, the Red Sea and the Gulf of Siam. Many Arctic and Atlantic species were also in the list.

The *Radiolaria*, though not abundant as to individuals, revealed a large number of species of which only a small part have as yet been carefully examined. Of the 33 studied a few are cosmopolites and most of them rare, known hitherto only from a single or at most a few specimens from *Challenger* collections in the tropical Atlantic and Pacific Oceans. One only was reported from the North Atlantic 57° N. latitude off Greenland, and others in hauls from great depths in mid Atlantic or Pacific, *e. g.*, in 2,250 fathoms or more.

Three pelagic Foraminifera which are cosmopolitan in the plankton occurred in the collections, and some bottom ooze cursorily examined appears to be rich in other forms which have not as yet been identified.

There were also four other forms belonging to other groups of protozoa, two ectoparasites on other pelagic organisms, one endoparasite and one flagellate free swimming in habit.

The affinities of the local protozoan fauna are to some extent with that of tropical waters, though some apparently northern forms appear in our lists. Apparently the protozoan fauna of the Bay of Naples, and perhaps that of the tropical Atlantic and Pacific, are to be found within a few hours' sail of San Diego.

Dr. Torrey's intimate knowledge of the actinozoa and hydroidea of the California coast enabled him to make the best of the little dredging and trawling and shore collecting done, and his preliminary report which follows, includes these as well as the pelagic groups:

The Cœlenterata are represented in the waters in the neighborhood of San Diego, Cal., by at least 86 species, more than half of which have not been found before in this region.

Among the medusæ, nineteen genera of craspedotes and one genus of acraspedotes have been taken, each represented by one species. Of these species, only four (*Aurelia labiata, Phialidium gregarium, Proboscidactyla flavicirrata, Thaumantias cellularia*) have been reported previously from this coast; three (*Cladonema radiatum, Tiara pileata, Tiaropsis diademata*) are known in the eastern United States or in Europe; of the remaining thirteen, seven are in all probability new to science.

Six species of Siphonophora, representing as many genera, have been collected. Two are old species, world-wide in their distribution (*Sphæronectes köllikeri, Diphyes appendiculata*). The others have not been closely identified, owing largely to their fragmentary condition; two are physonects, two cystonects.

Four species of Ctenophora, each representing a genus, have been collected. Two of these are well known north of San Francisco (*Pleurobrachia bachii, Beroe cyathina*). The third (*Mertensia* sp.) closely resembles the *M. ovata* of the eastern coast. The fourth is a lobate, which has appeared only in immature stages and can not be placed accurately until the adult form is known.

These floating forms were obtained by the tow-net at the surface and in vertical hauls from depths varying from thirty to one hundred and sixty fathoms. Some of the species were taken in almost every haul at whatever depth (*Diphyes appendiculata, Sphæronectes köllikeri, Glossocodon* sp., *Obelia* sp., *Mertensia* sp.). Most of them are represented by less than six individuals, some by but a single specimen.

On the shores of San Diego Bay, Point Loma, Coronado and the Coronado Islands, and in hauls of the dredge at depths varying from three to fifty fathoms, off Point Loma and in the mouth of the bay, there were obtained thirty species of hydroids representing fifteen genera, nine species of anemones representing six genera, two species of madrepore corals and five species of alcyonarian corals.

Of the thirty species of hydroids, at least four are new to science, eleven others have not been found here before, and two are new to the Pacific Coast. If to these thirty species there be added the fourteen previously reported but not obtained this season, the resulting total of forty-four will surpass the total known for any other region south of Puget Sound, and embraces representatives of nine of the eleven families known on the coast.

Of the nine anemones, all save one (*Sagartia* sp.) are found at San Pedro, two reaching beyond that point to the north, one to Puget Sound (*Epiactis prolifera*), the other to Santa Barbara (*Anthopleura californica*). All are peculiar to this coast.

None of the six corals are new species, but, so far as can be judged at present, are peculiar to the Pacific Coast.

Mr. Esterly summarizes the results of his study of the pelagic copepods as follows:

Twenty-seven species were recognized, of which twenty-two were accurately determined. These belonged to the following genera: *Acartia, Calanus, Euchirella, Heterochäta, Metridia, Oithona* and *Sapphirina*. Five of the twenty-seven species have not been reported previously outside the Mediterranean Sea. Four are new to North America.

The list of species obtained by the *Albatross* dredging on the west coast of South America and Mexico, and in the Gulf of California in 1891, contains forty-eight names. This number can now be increased by fourteen determined species, at least on the west coast of the Americas. Five of the species identified are common to this and the Woods Holl region on the Atlantic

coast. Considerable numbers of both males and females of a species undoubtedly new were found in San Diego Bay.

The tornaria described by me in 1893* was taken this summer for the first time since the original discovery. Only a few specimens were secured at Santa Catalina, its first locality. This year it was abundant during the whole period of our work. Its habits and structural changes during metamorphosis were consequently studied to good advantage. Furthermore, Mr. Davis found it a particularly interesting subject for his studies on the flotation, specific gravity and modes of locomotion of pelagic animals.

Nearly all the specimens taken were from nets that had been down to from thirty-five to ninety fathoms. Almost none occurred in surface towings. In spite of rather extensive experiments by both Mr. Davis and myself to determine the influence of light on the larva's movements, conclusive results were not obtained.

This tornaria is certainly closely related to, if not identical with, the Bimini larva figured by Morgan,† pl. I., fig. 12. In addition to this tornaria an occasional specimen of another species undoubtedly new to science and quite distinct, was found. This form is especially characterized by the possession of as high as seven pairs of branchial pockets before there are other obvious signs of metamorphosis.

Of the pelagic tunicata, only the genus *Oikopleura* representing the Larvacea has yet been taken on the coast of California. Apparently two species of this genus occurred rather abundantly in the tow throughout the summer. The extreme sensitiveness of these animals to removal from the sea itself is a striking phenomenon in the ecology of pelagic organisms and richly deserves investigation.

But a single species of *Doliolum* was taken, and that represented only by the 'nurse'; but this species is particularly interesting, it being clearly the peculiar form hitherto known only from the specimens taken by the *Challenger* and described by Herdman in his report on the pelagic tunicata of the expedition.

Of the seven or eight species of *Salpa* now known from the California coast only five were found during the summer; of these, however, one was taken for the first time, and is a new species. *S. runcinata-fusiformis* was by far the most abundant species.

Pyrosoma atlanticum var. *tuberculosum* was taken in considerable numbers, and is the first record of a member of this genus on our coast so far as our collecting is concerned.

Owing to the little dredging and trawling and shore collecting that were done, only about fifteen species of sedentary ascidians were obtained. The great abundance of *Ciona intestinalis* on the floats and piles of the laboratory is worthy of mention as showing the ease with which this species may be obtained in unlimited quantity for experimental or morphological studies.

A wealth of life representing other subdivisions of the animal kingdom came to the laboratory, but, owing to a lack of workers, could only be admiringly looked at and put into preserving fluids to await attention in the future.

Mention should be made of the fact that the species of *Gonyaulax* which appeared in such enormous numbers in the summer of 1901,* occurred at San Diego this year

* 'On a New Balanoglossus Larva from the Coast of California, etc.,' *Zool. Anz.*, XVII. Jahrg., 1894, p. 24.

† 'The Development of Tornaria,' *Journ. of Morph.*, Vol. IX., p. 1.

* H. B. Torrey, 'An Unusual Occurrence of Dinoflagelata on the California Coast,' *Amer. Naturalist*, Vol. 36, March, 1902. Also W. E. Ritter, 'A Summer's Dredging on the Coast of Southern California,' Science, January 10, 1902.

quite as abundantly as it did that year at San Pedro. During the last days of July the water of the ocean at Coronado extending from the shore out to a mile or more took on the rusty color, increasing at times and in places to almost that of old blood clot, with which we became so familiar at San Pedro two years ago. This year, however, we observed nothing of the fatality among other animals, as an accompaniment of the visitation, that occurred in 1901. It is not certain, however, that this latter phenomenon was absent, for we did not have the same opportunities for observation this year that we had before. This year we did no dredging in the affected region and consequently had no chance to see how the bottom organisms were affected. Furthermore, there was no high wind this year to drive the *Gonyaulax* on to the shore and to cast up the dead of other animals, had they existed.

As mentioned above, the same kind of work will be carried on again for two weeks during the Christmas recess of the university. This much we are now able to do toward realizing the plan of distributing the survey operations throughout the year.

It gives me genuine pleasure to conclude with an acknowledgment of our obligations to the citizens of San Diego for having made the work possible this year. The whole expense of moving the laboratory from San Pedro and of fitting up the new one at Coronado, and likewise all the expense of carrying on the work excepting for the equipment that was taken from the university, was provided by the citizens. A committee of the chamber of commerce of that city had the matter in charge, and such a duty was certainly never more efficiently discharged by any similar body of men.

Wm. E. Ritter.

University of California,
August 14, 1903.

SCIENTIFIC BOOKS.

THE COLLECTED PAPERS OF ROWLAND AND FITZGERALD.

The Physical Papers of Henry Augustus Rowland. Collected for publication by a Committee of the Faculty of the University. Baltimore, The Johns Hopkins Press. 1902. 8vo. Pp. xi + 704.

The Scientific Writings of the Late George Francis FitzGerald. Collected and edited with a historical introduction by Joseph Larmor. Dublin University Press Series. Dublin, Hodges, Figgis & Co., Ltd.; London, Longmans, Green & Co. 1902. 8vo. Pp. lxiv + 576.

No more fitting memorials could have been produced in honor of the two distinguished physicists, whose untimely deaths occurred in the early months of 1901, than these admirable volumes issued by the Johns Hopkins Press and by the Dublin University Press respectively. The first duty of the living, therefore, is to acknowledge our deep indebtedness to Professor Ames and to Professor Larmor on whom the burden of the work fell in collecting and editing these widely scattered papers and in bringing them into readily accessible forms in the short space of two years. They have thus at once rendered homage to the heroes who have gone before and encouragement to the hosts who follow in the arduous march of physical science. The desirability of republication of the scattered papers of eminent men of science is now pretty generally recognized, and the prompt issue of the papers of Rowland and FitzGerald sets an example which should be widely followed.

The nearly simultaneous appearance of these two volumes tends to emphasize a remarkable similarity in the careers of Rowland and FitzGerald. Each was the son of a clergyman; each was a physicist by nature in spite of all educational influences that might have led his thoughts along other lines; each was in the van of the great progress in physical science of the last thirty years; each was a vigorous champion of the laboratory method in scientific studies; each advocated in the strongest terms the merits of pure re-

search; and each sacrificed himself, we might almost say, in his unflagging efforts for the advancement of science.

The appearance of the volumes recalls attention, also, to the singular fatality which has prevailed in the ranks of the leaders in electro-magnetic science. Maxwell, Hertz, FitzGerald and Rowland all fell while yet in the prime of life. Were they victims to overwork, or did they sap their vitality in their early struggles for the recognition essential to secure them the means of subsistence? Possibly there is more truth than poetry in Rowland's question in his address on 'The Highest Aims of the Physicist'—'Where can the discoverer in science earn more than the wages of a day laborer or cook?' No doubt each of them had to do combat with many obstacles other than those which nature sets up in the way of learning her laws, for society does not appear to have discovered any method as yet to prevent the waste of effort involved in surmounting such obstacles. Society, indeed, seems to be almost wholly unconscious of the value to itself of its most important members. Our best known and most applauded heroes of state are still those who win renown by shedding human blood. Nevertheless, Rowland and FitzGerald lived during a period of great progress toward a higher civilization than that into which they were born. Each of them contributed nobly and effectively to that progress, and the scientific world, at least, gave them its heartiest encomiums.

As indicated by the title, the volume of Rowland's papers contains reprints only of those devoted especially to physical subjects, although the bibliography included in the work embraces all of his published papers. The preface and table of contents of the volume are followed by the capital commemorative address of Dr. Mendenhall, read before an assembly of friends at Baltimore, October 26, 1901. The many interesting facts and incidents from Rowland's career related in this address would tempt one to quote freely from it if it had not been published already in this journal.*

* 'Henry Augustus Rowland': T. C. Mendenhall. SCIENCE, N. S., December 6, 1901. Pp. 865–877.

The papers are arranged in groups under the following heads: Part I., 'Early Papers'; Part II., 'Magnetism and Electricity'; Part III., 'Heat'; Part IV., 'Light.' Then follow a list of addresses, six in number; a full bibliography, embracing 72 titles; and a description, with suitable plates, of the dividing engines devised by Professor Rowland. The latter description and plates were prepared by Professor Ames, Professor Rowland having left no records with respect to these machines.

Two lifelike portraits of Professor Rowland are included in the volume; and it is hardly necessary to add that so fine a memorial and so good a specimen of book-making is supplemented by an adequate index.

The text of FitzGerald's papers is preceded by a most interesting and instructive account of his life drawn from communications to the *Electrician* and to the 'Obituary Notices of the Royal Society' by Principal O. J. Lodge; to *Nature* by Dr. Larmor; to the *Proceedings of the Institution of Electrical Engineers* by Professor F. T. Trouton, and to the *Physical Review;* embracing in all pp. xx–lxiv. These reveal not only a man of remarkable originality and versatility in science, but a man also of the gentlest and broadest sympathies. Few men in any sphere of intellectual activity have been so generally esteemed with affectionate regard by their contemporaries.

The papers are arranged in the chronological order of their first publication. There are 108 of them, the first having been published in 1876. They touch a wide range of subjects, and although some of them are condensed to the merest abstracts they are generally bristling with clear ideas and fruitful suggestions.

Amongst the most useful as well as most interesting of these writings are his reviews and semi-popular addresses. The latter, especially, deserve to be widely read, since they are luminous with the spirit of progress of our age, not only for the small number of scientific specialists but for the whole human race. In what he has to say about 'Universities and Research,' No. 60, 'Science and Industry,' No. 77, 'Lord Kelvin's Researches,' No. 78, 'The Applications of Science,' No. 95,

he proves himself a prophet and a statesman in the best senses of the words, as well as an eminent representative of natural philosophy.

The editor has properly anticipated that the volume will be much consulted, and he has supplied an index which will prove particularly useful to those not already acquainted with the scope of importance of FitzGerald's writings. An excellent portrait accompanies the volume as a frontispiece.

R. S. W.

Lehrbuch der vergleichenden Anatomie. By B. Haller. Erste Lieferung. Jena, Gustav Fischer. 1902.

This book, the first portion of which is here considered, is intended by the author to fill the gap left vacant by the aging of Gegenbaur's 'Grundriss der vergleichenden Anatomie,' a book familiar enough to the older generation of zoologists, but now almost unknown, its last edition having appeared some twenty-five years ago.

The 'Grundriss' was what its title denotes, a comparative anatomy as contrasted with a zoology, or, in other words, a concise exposition of the various systems of organs in their modifications and adaptations throughout the animal kingdom, rather than a description of the morphological characteristics of the various classes of animals. That such a book, brought up to date, would fill a gap in our zoological literature there can be no doubt, but that the volume before us does so is more than questionable. For it is a compromise; it is a zoology as far as its general plan is concerned, and a comparative anatomy only so far as each great zoological group is concerned. Its plan is essentially the same as that of Lang's 'Lehrbuch,' though on a less extensive scale, and because it is less detailed the defects of the plan are all the more pronounced.

And even more to be criticized is the classification which has been adopted for the achordata, which alone are treated in the portion of the book before us. The recognition of a group Vermes, including the platyhelminths, nemathelminths, rotifera, chætognaths and annelids, and a group Arthropoda including crustaceans, arachnids, protracheates and tracheates as of equal value with a group Bryozoa and a group Brachiopoda, not only indicates a depressing lack of taxonomic perspective but leads the student to erroneous conceptions of the affinities of the invertebrate phyla, thereby depreciating one of the prime values of comparative anatomy.

The contents of the book, apart from these general defects, are on the whole good and cover the proposed ground as completely as could well be expected within the limits set. They may, however, be criticized for a lack of clearness, attributable to a certain extent to the unfortunate arrangement of topics and for occasional errors of statements. Among the latter may be mentioned the description of the mesenterial filaments of the Anthozoa as 'finger-shaped processes' arising from the edges of the mesenteries, an error repeated in the figure illustrating the structure of an Anthozoan, and the rather scant reference to the coxal glands of the Xiphosura and arachnids as integumental organs.

The figures are numerous and on the whole well chosen and admirably reproduced. The text, however, awakens wonderment by the extraordinary number of typographical errors which it contains. The technical terms offend especially in this respect, though by no means exclusively, and though it would be an exaggeration to say that an error occurs on almost every other page, one cannot help wondering how the proof-readers could have allowed so many flagrant errors to escape notice. Achorodaten (Achordaten), Hiozoen (Heliozoen), Mikrocoma, Hyppocrane (Hippocrene) and Pachyrchina are hardly recognizable in such novel guises and *Paramœcium* masquerades as *Paramœtium, Parametium* and *Paramœtium.* But disturbing as these examples may be, it gives one an actual shock to find *Loxosoma* quoted as a multinucleated infusorium, *Idotea* as an opisthobranch mollusk, and after reading a paragraph concerning the Phronimidæ to discover that the author is really talking about the Phoronidæ. There is probably an explanation for such remarkable errors, but there cannot be a valid excuse for them.

With all these defects the book is hardly one to be recommended to the young student. It would almost be better for him to hunt up the time-honored 'Grundriss.'

J. P. McM.

SOCIETIES AND ACADEMIES.

THE AMERICAN POMOLOGICAL SOCIETY.

THE American Pomological Society held its twenty-eighth bienniel meeting at Boston on September 10, 11 and 12. Among the papers on the program were, in addition to the address of the president, Professor Charles Watrous, of Des Moines, Ia., the following:

DR. L. H. BAILEY, Cornell University, Ithaca, N. Y.: 'The Attitude of the Schools to Country Life.'

MR. J. HORACE MCFARLAND, Harrisburg, Pa.: 'Fruit Gardens, what they are and what they are for.'

PROFESSOR S. B. GREEN, St. Anthony Falls, Minnesota: 'Hardy Fruit Gardens.'

PROFESSOR E. J. WICKSON, University of California, Berkeley, Cal.: 'Fruit Gardens of the Pacific Coast.'

MR. G. HAROLD POWELL, pomologist in charge fruit storage investigations, U. S. Department of Agriculture: 'Relation of Cold Storage to Commercial Orcharding.'

DR. C. L. MARLATT, first assistant entomologist, U. S. Department of Agriculture: 'The San Jose Scale in the Orient.' (Illustrated.)

HON. W. A. MCKINNON, chief of Fruit Division, Department of Agriculture, Ottawa, Canada: 'Fruit Inspection and the Export Trade.'

MR. GEO. T. POWELL, Ghent, N. Y.: 'Should the Commercial Grower Plant Varieties of High Quality?'

DR. W. D. BIGELOW, acting chief, Bureau of Chemistry, U. S. Department of Agriculture: 'Pure Food Legislation and its Relation to the Fruit Grower.'

PROFESSOR F. W. TAYLOR, chief, Department of Horticulture, St. Louis, Mo.: 'Pomology at the St. Louis World's Fair.'

DISCUSSION AND CORRESPONDENCE.

THE BAHAMAS VS. TORTUGAS AS A STATION FOR RESEARCH IN MARINE ZOOLOGY.

FROM June 4 to July 27 the writer was in charge of an expedition of the Museum of the Brooklyn Institute of Arts and Sciences which had for its object the study of the coral reefs and marine zoology of the Bahamas. The writer had already enjoyed the privilege of studying the marine zoology of the Bahamas during the winter months while acting as assistant to Dr. Alexander Agassiz upon the *Wild Duck* expedition of 1892–93.

Having now seen the conditions in the Bahamas in summer as well as in winter, the writer feels justified in drawing a comparison between this region and that of the Tortugas in reference to their comparative advantages as stations for the establishment of a laboratory for research in marine zoology.

Nassau, the capital of the Bahamas, is a clean, healthful city attractively situated upon hills of *æolian* rock and possessed of a good harbor.

The social conditions commonly found in English colonies are here well developed, and one meets with gracious treatment both from the government officials and from the residents of the islands. It is certain that were a laboratory for research in marine biology to be established in the Bahamas, under good auspices, the community would extend a cordial welcome to the investigators and render their sojourn in the colony pleasant in every way.

The harbor of Nassau is a long, narrow trough bordered on the south by the island of New Providence and on the north by Hog and Rose islands. A very strong tidal current sets through it, flowing eastward with the flood and westward with the ebb-tide, the current being of such strength that it is necessary only to anchor in the tide-way and throw over a tow-net in order to make a surface haul under ideal conditions. This is an advantage possessed by but few localities and would enable a laboratory to supply itself with a practically continuous surface haul.

Unfortunately, however, the surface hauls are very poor in comparison with those from the Tortugas. The prevailing winds in the Bahamas during the summer are from an easterly direction, and these drive the surface water into Nassau harbor from over the shallow flats which extend for about seventy-five miles between New Providence and Eleuthera

island. In common with most of the Bahama banks these shallow flats are veritable submarine deserts. Here and there one finds a small cluster of coral heads and gorgonians, but almost everywhere the bottom is a flat barren waste of sand supporting a sparse growth of coralline algæ. Not only is the bottom deficient in living forms, but the pelagic life in the water over these flats is poor to an even more marked degree both in number and variety of forms. This water is more or less charged with a flocculent mass of finely divided mud similar to that commonly met with off the mainland coast of Florida, and evidently churned up by the currents caused by winds and tides. This floating material clings readily to pelagic animals and plants and appears to be rapidly fatal to the majority of pelagic creatures. Among medusæ only a few species allied to *Gonionemus* appear to thrive in this water of the Bahama banks.

Almost no Sagittæ or Salpæ and remarkably few Crustacea or Medusæ are found in the water of the shallow banks, whereas these forms are abundant over the Tongue of the Ocean where the depth varies from 500 to 1,000 fathoms, and to the northward of New Providence Island in water 1,500 to 2,000 fathoms deep. Indeed, whenever the wind becomes reversed and comes from a westerly direction the pelagic hauls in Nassau harbor become rich in truly oceanic forms which have evidently drifted in from the Tongue of the Ocean.

An idea of the relative poverty of the pelagic fauna of the Bahamas as compared with that of the Tortugas will become apparent from the fact that the most assiduous efforts in surface hauls at the Bahamas brought to light only 43 species of medusæ, while 90 species were found by the writer at the Tortugas. The writer once drew a large surface net for three miles through the most promising looking 'slick' over the bank without capturing a single marine animal.

The coral reefs of the Bahamas are richer than those of the Tortugas where the corals were largely killed twenty-four years ago by a sudden influx of 'poisoned' water apparently from the mainland of Florida.

A wonderful reef, rich especially in *Madrepora, Agaricia, Dendrogyra* and Gorgonians stretches along almost the entire eastern shore of Andros Island. At New Providence Island also one finds a remarkable reef abounding in *Porites, Mœandrina, Madrepora palmata* and Gorgonians off Clifton Point, while another cluster especially rich in *Mœandrina* and *Orbicella* lies off the eastern point of New Providence. There are also good reefs within Nassau harbor, and, indeed, the expedition met with remarkable success in its collection of corals, obtaining some of the largest and most perfect stocks ever taken from the West Indian region.

In comparison with that of the Tortugas reefs the fish fauna of the Bahamas is markedly poor. It is evident also that the invertebrates are not so abundant among the Bahamas corals as they are among those of the Tortugas. This, however, does not apply to the Actinians, which are more numerous in both number and variety than at the Tortugas.

The Bahama region is richer in corals, poorer in fishes and invertebrates, and far poorer in pelagic life than that of the Tortugas. Indeed, as Bigelow aptly states, the Bahamas lie upon the wrong side of the Gulf Stream. In this respect the situation of the Tortugas is almost ideal, for they are surrounded by the purest of ocean water, and the prevailing winds, both in summer and winter, drift upon their shores the rich pelagic life of the Gulf Stream.

It is true that the Tortugas afford practically no opportunity for the study of land fauna or flora, but there is no place known to the writer in the American Tropics where both land and marine faunæ are exceptionally rich. For the study of marine life we must seek the borders of the Gulf Stream.

In considering the question of the establishment of a laboratory for research in marine zoology we must, I think, confine ourselves to the problem of the study of the ocean and leave that of the study of the land fauna to

another laboratory especially designed for such a purpose.

In recent discussions in Science it is apparent that some of the correspondents were ignorant of the conditions which have prevailed since 1898 at the Tortugas.

The station is now a naval coaling base and a large and comfortable tug makes regular trips twice a week to and fro between the Tortugas and Key West, leaving at 8 A.M. and arriving at about 2 P.M. Even during the writer's earliest visits to the region it was never necessary to charter a vessel in order to proceed from Key West to the Tortugas, as has been implied by one of the correspondents.

The climate of the Tortugas is cooler than that of the Bahamas, owing to their smaller land mass and the refreshing influence of the ocean breeze. In both Bahamas and Tortugas the breezes throughout the months of May to August are usually so gentle that one may make studies of the windward sides of the reefs on almost any day, using very small rowboats. The yellow fever quarantine station was abolished at the Tortugas in 1899, and there are practically no mosquitoes on Loggerhead or Bird Keys.

Although the community at the Tortugas is small the social conditions are pleasant, for people of culture and education are sure to be found among the naval officers and their families, and indeed, the writer recalls with keen pleasure many most enjoyable hours spent in company with one of the keepers of the lighthouse. The community is sufficiently small not to distract, but yet large enough to render pleasant and profitable the few leisure hours which may be enjoyed by one engaged in marine research. The Tortugas is in telegraphic connection with Key West, and a naval surgeon is stationed at Fort Jefferson.

Alfred Goldsborough Mayer.

SHORTER ARTICLES.

THE BRAIN-WEIGHT OF THE JAPANESE.

Investigations concerning the weight of the brain in the non-European races have hitherto been exceedingly limited. All that was known of the brain-weight of the Japanese was confined to a few statistics reported by Doenitz* (1874), Taguchi† (1881) and Suzuki‡ (1892), comprising in all 130 brains. These were nearly all of persons who were decapitated in the time of the 'Meiji.' The average brain-weight of 100 males was found by Taguchi to be 1,356 gms.; while Doenitz gives 1,337 gms. for 10 male subjects. Professor K. Taguchi,§

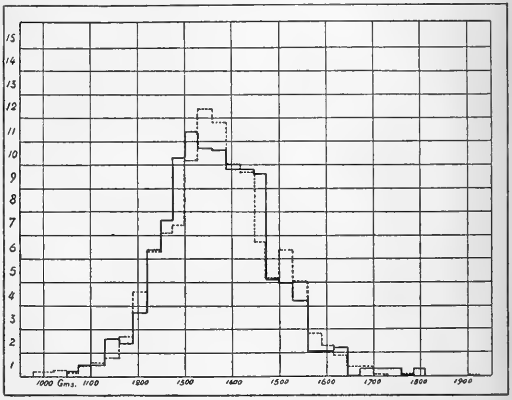

Fig. 1. Chart showing distribution of 374 male Japanese brain-weights (continuous line) as compared with 1,012 German brain-weights (broken line) of the Bischoff-Marchand series. For convenience in comparison, both series are tabulated on a basis of 100 cases each.

of Tokyo University, recognizing the need of fuller statistics, began ten years ago to record systematically brain-weights together with data concerning stature, age and body-weight. His researches are based upon 597 subjects; 421 males and 176 females, mostly from the hospitals. The average brain-weight of 374

* Doenitz, 'Mitth. d. deutsch. Gesellsch. f. Natur. u. Völkerk, de Ostasiens,' Yokohama, 1874.

† 'Kaiboranyo,' Vol., 1881, p. 18.

‡ *Tokyo Medical Gazette*, VI., 1892, p. 518.

§ K. Taguchi, 'On the Weight of the Encephalon of the Japanese,' *Sei-I-Kwai Medical Journal*, Tokyo, Vol. XXII., Nos. 1, 2 and 3, 1903. Also in *Neurologia*, Vol. I., No. 5, 1903.

adult males (ages 21–95) is 1,367 gms. (max. = 1,790; min. = 1,063); of 150 adult females it is 1,214 gms. (max. = 1,432; min. = 961). The sexual difference of these averages is 153 gms., about the same as in Europeans.

TABLE I.

Males.

Age.	Japanese. (Taguchi) (397).	Germans. (Bischoff) (545).	Germans. (Marchand) (493).	Russians. (Giltschenko) 720.	Swedes. (Retzius) 350.	Czechs. (Matiegka) 306.
14–20	1,345	1,340	1,404	1,413	....	......
20–30	1,350	1,396	1,416	1,394	1,434	1,475
30–40	1,374	1,365	1,391	1,358	1,412	1,467
40–50	1,391	1,366	1,403	1,345	1,388	1,423
50–60	1,389	1,375	1,370	1,347	1,392	1,445
60–70	1,381	1,323	1,370	1,267	1,349	1,419
70–80	1,333	1,279	1,324	1,284	1,340	1,367
80 and over.	1,342			1,289		1,442

Females.

Age.	(156)	(341)	(266)	( )	(250)	(205)
14–20	1,226	1,242	....	....	....	....
20–30	1,264	1,234	1,293	....	1,279	1,309
30–40	1,210	1,233	1,267	....	1,268	1,332
40–50	1,179	1,240	1,260	....	1,246	1,298
50–60	1,252	1,200	1,260	....	1,237	1,266
60–70	1,219	1,178	1,215	....	1,244	1,245
70–80	1,202	1,121	1,159	....	1,195	1,242
80 and over.	1,102			....		1,189

In order to better understand the distribution of these brain-weights as compared with those of Europeans, the writer has employed Taguchi's figures in the preparation of the accompanying chart (Fig. 1). The distribution of the (374) male Japanese brain-weights (continuous line) is seen to correspond fairly well with that of (1,012) male German brain-weights (broken line) of the Bischoff-Marchand* series. The comparison can be fairly made, since the weighings were made according to similar methods in both series.

Taguchi has no records of the weight of the brain in the new-born, but has 156 brain-weights of children ranging from two months to fourteen years of age. Comparing these with similar records of European children (Pfister, Mies, Marchand), it is evident that the growth of the Japanese brain is slower. The brain of the Japanese boy between nine and fourteen years of age weighs about 1,235 gms., while that of the European of the same age weighs 1,300–1,350 gms. Among adults there is a gradual increase up to the fifth decade. Table I. shows the weight of the brain in the various decades in comparison with those of Germans (Bischoff and Marchand), Swedes (Retzius), Czechs (Matiegka) and Russians (Giltschenko). The maximum is attained in the fifth decade among the Japanese males; in the female series two maxima occur, one in the third, the other in the sixth decade. The necessity of obtaining still more extensive statistics is, therefore, apparent.

The relation between brain-weight and stature is as positive as is observed in the European series. The Japanese are a people of small stature, however, and this fact lends interest to the question of relative brain-weight. It is a little difficult to institute very satisfactory comparisons with the European records since Taguchi's methods of tabulation are different from those generally employed. The following table may help the reader to interpret the relations of brain-weight and stature among Europeans (Germans, Russians and Czechs) and in the Japanese series.

TABLE II.

Males.

Japanese. Stature.	Japanese. (226.)	Stature.	Marchand (439).	Bischoff (390).	Giltschenko (720).	Matiegka (269).
138–148	1,324	145–150	......	1,307	1,342	......
148–158	1,355*	151–160	1,360	1,339		1,403
158–168	1,380	160–164	1,388	1,341	1,359	1,417
		165–170		1,355	1,375	1,430
		171–180	1,404	1,389	1,404	1,457
		180 and over.		1,375		1,496

* See the writer's review of Marchand's 'Ueber das Hirngewicht des Menschen,' SCIENCE, N. S., Vol. XVII., 1903, p. 345.

* In the original this figure is given as 1.535 gms. This is manifestly a typographical error; it should be 1.335 or 1.355 instead. The latter figure is more likely to be correct.

Another mode of interpreting these results is to calculate the number of grams of brain-weight per centimeter of stature (Table III.). This shows that the relative brain-weight is about the same in the races mentioned and only in the very small Japanese individuals is the ratio high. The small stature of these people is therefore more characteristic of the race than is the absolute brain-weight.

TABLE III.

Males.

Grams per Centimeter of Stature.

	Germans.		Russians.	Czechs.	Japanese.
	Bischoff.	Marchand.	Giltsch'ko.	Matiegka.	Taguchi.
Less than 150 cm.					9.3
150	8.7	9.2			
155			8.6	9.0	8.7
160	8.3	8.4			
165	8.1	8.2	8.4	8.6	8.5
170	7.9	7.9			
175	7.6	7.8	7.9	8.3	
180		7.8			
185				8.1	
190	7.1	7.8			

As regards the relation of brain-weight and body-weight there are bound to be great diversities of opinion as to the average ratio. Bischoff's ratio is 1:36.6 in males, 1:35.2 in females. Vierordt's more extensive tables give 1:46.3 in males, 1:44.8 in females. Taguchi finds 1:38.3 and 1:42.9 respectively in his Japanese series. The weight of the body is, however, a very unsatisfactory standard for comparison since the mode of death and other factors exert a great influence upon it. Such objections can not be raised against employing the stature as a basis for estimating relative brain-weight.

To recapitulate, the brain of the Japanese grows more slowly during infancy and early youth than it does in the European. In the adult the brain-weight compares favorably with that of Europeans of similar stature and it may be shown to be superior in this respect to other races of the same general stature. These facts are of not a little significance in relation to the learning, industry and aptitudes of this progressive race.

E. A. SPITZKA.

GONIONEMUS VERSUS 'GONIONEMA.'

WITH the growing multiplicity of names in zoological nomenclature and their great similarity, although referring to widely different forms, it is certainly a questionable practice to change the name of any animal unless there is urgent reason for doing so.

It is well known that names of animals are not all good etymology or derivation, but this should not be sufficient ground for changes. A name once given an animal by proper authority is its name irrespective of etymology or its significance, and would better not be changed in most cases for any less reason than being preoccupied.

As *Gonionemus* is a jellyfish that will be frequently referred to, on account of its being used both in many experiments and in universities and colleges for class study, it is desirable to have the form of its name established.

Haeckel ('System der Medusen') first changed Agassiz's naming of the genus to '*Gonynema,*' because he supposed the name was intended to mean 'kneed thread.' And in the light of Agassiz's description ('North Am. Acalephæ,' 1865), in which he said '* * * the moment a blade of kelp touches their disc, they stop, bend their tentacles *like knees,* and remain attached to the seaweed * * *,' it is evident that he meant to use for part of the name the word that refers to knees. If the name were to be changed, therefore, it should be *Gonynema,* which would also be correct in construction.

The form of the name '*Gonionema*' was first published by Yerkes (*Am. Jour. of Physiol.,* Vol. VII., No. 2) and since then used by others, but here again only the ending is corrected and it still remains to change the end of the first part, making it *Gonianema.** Dr. Perkins (*The Proc. of the Acad. of Nat.*

* Since the above was put into type a letter from Professor Agassiz states that, in 1859, in making the name Gonionemus he meant to suggest 'something with knees browsing about in the huge kelp,' which reminded him of a grove. According to this, then, the part of the name in question is from '*nemus*' and the original ending is the proper one.

Sciences, Phila., March 7, 1903) in his interesting paper on 'The Development of *Gonionema*' first gives the authority of Agassiz approving the correction, but in view of the confusion that might arise I propose to retain the name *Gonionemus*, originally given the genus by Professor Agassiz, and would like to urge that future writers use this form.

L. Murbach.

Detroit, Mich.

BOTANICAL NOTES.

MOSSES.

Dr. A. J. Grout has just published 'Mosses with Hand-Lens and Microscope, Part I.,' as a quarto pamphlet of 86 pages. This is a 'non-technical hand-book, of the more common mosses of northeastern United States,' and is the outgrowth of 'Mosses with a Hand-Lens,' published by the same author a few years ago.

After a brief introduction, chapters are given dealing with classification and nomenclature, collection and preservation, mounting and methods of manipulation. The life history and structure of the moss plant are then given in some detail. Since the peristome is of considerable importance in indicating the relationships of mosses, the discussion of its structure is given due prominence in this section. An illustrated glossary of bryological terms constitutes a valuable feature of the work.

After listing the more important works on mosses for American students, the author takes up the systematic study of the more common forms. The key to the families is followed by the treatment of the Sphagnaceæ, Andreaceæ, Georgiaceæ, Polytrichaceæ, Buxbaumiaceæ, Fissidentaceæ and Dicranaceæ in part, leaving the remainder of the twenty-seven families recognized for treatment in subsequent parts (four to five parts in all will be issued). The classification adopted does not deviate very much from that given in Dixon and Jameson's 'Hand-book of British Mosses.' In the matter of changes in nomenclature the author has been quite conservative.

The work is illustrated with a considerable number of figures in the text, besides ten full-page plates. The fact that the latter are reproductions from 'Recherches sur Les Mousses,' by Schimper, 'Bryologia Europea,' and Sullivant's 'Icones Muscorum' is sufficient guarantee for their excellence. The purpose of the work is best given in the words of the author: 'To give by drawings and descriptions the information necessary to enable any one interested to become acquainted with the more common mosses with the least possible outlay of time, patience and money,' but we doubt if the author's prediction, 'that it makes the mosses as easy to study as the flowering plants,' will ever be realized. The beginning student will find Dr. Grout's publication a very valuable aid, and by those who do not have the more exhaustive treatises at their command it will be especially prized.

MORPHOLOGY OF ANGIOSPERMS.

Students of morphology will welcome the appearance of 'Morphology of Angiosperms,' by Dr. J. M. Coulter and Dr. Chas. J. Chamberlain, from the press of D. Appleton & Co. It is worthy of note that this work is not issued as Part II. of the 'Morphology of Spermatophytes,' as was the intention when its companion volume dealing with the Gymnosperms was published in 1901. This may be taken as a protest against considering the Spermatophytes as a group coordinate with the Pteridophytes.

The present volume, to use the authors' words, "Has grown out of a course of lectures accompanied by laboratory work, given for several successive years, to classes of graduate students preparing for research. It seeks to organize the vast amount of scattered material so that it may be available in compact and related form." After a brief introduction the following sequence of chapters is taken up: The flower, the microsporangium, the megasporangium, the female gametophyte, the male gametophyte, fertilization, the endosperm, the embryo. The chapter on the microsporangium ends with the formation of the mother-cells, and with their division the history of the male gametophyte is entered.

This line of separation is supported by the arguments of Strasburger, but even Strasburger has been known to change his opinions. To begin the gametophyte with the germinating spore certainly gives us a much clearer conception of the alternation of generations.

The history of the megasporangium is likewise terminated by the formation of the mother-cells, for their division is a reduction division, which is used as the basis of separation of sporophyte and gametophyte.

In the history of the male gametophyte the view that the tube-cell is the antheridium wall that develops a tubular outgrowth, 'while the generative cell and its products is the spermatogenous part of the antheridium' is given the preference. A careful reading of the chapter on the female gametophyte shows that the germination of the megaspore and formation of the gametophyte is not such a uniform process as most of our standard texts describe. In dealing with fertilization, 'double fertilization' is given due prominence, and the authors object to the use of the term as they consider it far from established that a real fertilization takes place; hence they prefer to speak of it as 'triple fusion.' The disputed centrosome question is touched upon and the authors' views may perhaps be gained from the following quotation: 'To say that all the figures that have been drawn have been mere products of the imagination would be a radical statement and one doubtless very far from the truth.' In the discussion of the endosperm its morphological character is touched upon, and while its exact nature is not considered established, the view that it is 'belated vegetative tissue of the female gametophyte, stimulated in a general way to develop by the act of fertilization,' is held as the most probable, although the possibility that it is a second sporophyte is admitted. Parthenogenesis and polyembryony are treated in the chapter on the embryo, and recent investigations seem to indicate that both are much more common than was formerly supposed.

In connection with each chapter there is a bibliography of the most important literature. An idea of the number of original papers consulted may be gained from the literature cited in the chapter on the female gametophyte, which includes 122 separate articles. The masterly way in which the vast amount of chaotic material has been handled is a commendable feature of the work, and we are inclined to think that the authors of some of our standard texts might consult it with profit.

Several chapters are given on classification, and it is encouraging to note that the authors have not found it necessary to develop a classification of their own but have been contented to adopt the classification of Engler and Prantl as given in 'Die Naturlichen Pflanzenfamilien,' as 'the best expression of our present knowledge, as applied to the whole of the Angiosperms.' The fact that 'this has not been pressed to the dreary details of minor groups,' but that general principles have been emphasized, makes these chapters of special value to the morphologist.

Separate chapters are given to geographic distribution, fossil Angiosperms and phylogeny of Angiosperms. The work closes with two chapters on the comparative anatomy of Gymnosperms and Angiosperms contributed by Professor E. C. Jeffrey, of Harvard University. Only a brief outline of the subject is attempted and perhaps some students will feel that a more extended treatment would have been advisable.

The whole work is illustrated with something over a hundred figures taken in large part from the original articles cited. The book is an admirable presentation of the subject and should be in the hands of every working botanist.

F. D. HEALD.
UNIVERSITY OF NEBRASKA.

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*INVESTIGATIONS IN PROGRESS AT THE UNIVERSITY OF CHICAGO.**

IN a former Convocation Statement I endeavored to point out in a general way that the officers of the University were engaged very directly and earnestly in the prosecution of special investigations. It was my purpose to show that a great share of the strength of the University was given to research and in-

* From the last quarterly statement of President Harper.

vestigation, as distinguished from administration and teaching. I desire at this time to indicate specifically, by way of illustration, the thought which at that time I endeavored to express. My illustrations are taken altogether from the Departments of Mathematics and the Natural Sciences. On a future occasion I shall use material which has been gathered from the departments ordinarily classed as the humanities.

The proposition which I wish to present is this: Nearly every member of every department in the university is to-day engaged in investigative work in which effort is being put forth to make new contributions toward the better understanding of the subject studied. I think it best under all the circumstances not to mention in this statement the specific names of persons thus engaged. In most cases, however, the mention of the subject itself will carry with it a knowledge of the person engaged in the work.

THE DEPARTMENT OF ASTRONOMY AND ASTROPHYSICS.

Mr. A is engaged in a systematic study of double stars with the forty-inch telescope. His great general catalogue of all known double stars in the northern heavens, which he has been preparing during the past twenty-five years, is about to be published by the Carnegie Institution.

Mr. B is engaged in a spectroscopic study of stellar motions with the forty-inch telescope. The results he has already published represent the highest degree of precision hitherto attained in this field. Through his initiative several observatories in Europe, Africa and the United States are cooperating in the observation of certain standard stars. The results of his investigations will serve as a basis for general studies of stellar relationships and motions, and also of the motion of the solar system with respect to the stars.

Mr. C is at work upon a triangulation of nearly 700 stars in various star clusters. These observations will serve as a basis for future investigations of the internal motions of these clusters. His observations of the Fifth Satellite of Jupiter are the only ones that have been obtained during the last five years, on account of the difficulty of observing this exceedingly faint object. In the cooperative plan of observing the minor planet Eros, participated in by many observatories in all parts of the world, he has obtained the most extensive series of observations, comprising over 1,500 measures on 73 nights. In addition to many other micrometrical observations with the large telescope, he has undertaken an extensive photographic survey of the Milky Way and other objects with the Bruce photographic telescope.

Mr. D is engaged in investigations on the motions of the minor planets, with particular reference to the characteristic planets of the Hilda type. He is also continuing his researches on effective potential forces.

Mr. E is engaged in a variety of theoretical investigations, most of which involve the application of the methods of modern mathematics to problems of celestial mechanics. He is giving special attention to a critical study of the nebular hypothesis on dynamical grounds, and is also at work on the theory of telescope objectives, with special reference to the use of non-spherical surfaces.

Mr. F's work on the design and construction of reflecting telescopes, and his photographs obtained with the two-foot reflector of the Yerkes Observatory have exercised a wide influence among astronomers. His color-screen method of converting a visual telescope into a photographic one has yielded excellent results with the forty-inch telescope and is being adopted in other observatories.

Mr. G is engaged in spectroscopic studies of various stars with the large telescope. This work relates particularly to certain very close double stars discovered by Mr. B and Mr. G with the Bruce spectrograph.

Mr. H is engaged in determining the brightness of a large number of stars, particularly those which vary in their brightness and which at minimum are beyond the reach of ordinary telescopes. Part of this work on very faint stars has been done in cooperation with two or three of the largest observatories in this country.

Mr. J's investigations relate to the general subject of stellar evolution, and are threefold in character:

1. Photographic studies of stellar spectra for the purpose of determining the physical and chemical condition and the order of development of certain great classes of stars. With the collaboration of two other members of the department, he has just completed an investigation of one of the two classes of red stars, including their chemical composition, physical condition, motion in the direction of the earth, order of evolution and relationship to the sun and other classes of stars.

2. Studies of the sun made for the purpose of elucidating both solar and stellar phenomena.

3. Laboratory investigations bearing on problems of solar and stellar chemistry and physics. With the collaboration of another member of the department, an investigation of spark spectra in liquids and compressed gases, and their bearing on the theory of temporary stars, has just been completed.

THE DEPARTMENT OF PHYSICS.

Mr. A is engaged in work upon a ruling engine for the production of diffraction gratings of a high order of perfection. Serious difficulties have been encountered, but considerable progress has been made upon this most important piece of work, and at present the prospect of attaining the end sought is highly encouraging. The efficiency of the gratings which it is hoped this machine will make will be at least twice that of the best gratings which have yet been produced. The difficulty of making a grating with twice the efficiency is as much greater than that of making the gratings which have been produced as the difficulty of making a telescope objective of eighty inches diameter is greater than that of making one of forty inches diameter.

Mr. A has also just begun an investigation of the effect of various agencies upon the position, breadth, distribution of light and intensity of spectral lines. He further expects to take up soon the problem of the velocity of light.

Messrs. B and C are engaged in the publication of a series of text-books which contain the most important of the undergraduate courses in physics which have been developed here. This work is considered necessary in order that the university may exert an adequate influence upon physics-teaching throughout the country. Two of these texts have already appeared and two more are nearing completion.

Mr. B is also cooperating with the Departments of Mathematics and Pedagogy in an endeavor to improve the teaching of mathematics and physics in the secondary schools, and is about to begin the collection of Mr. A's scattered works for publication in a single volume.

Mr. C is, in addition, engaged in an investigation of the nature of electric discharge in high vacua. This investigation is designed to test an important point in the modern electron theory of matter.

Mr. D is in the midst of a research upon the relation of the sparking potential and the spark distance for distances of the order of the mean free path of the molecule.

Mr. E is assisting Mr. A in the perfection of the ruling engine, and is also cooperating with Mr. C in the production of a physics text-book for elementary schools.

Mr. F is engaged upon two pieces of research: (1) an examination of the conditions which govern the coherence between metals; and (2) the influence of hysteresis upon electric resonance. Preliminary results of these investigations were presented by Mr. F to the American Association for the Advancement of Science at its recent meeting in Washington.

Mr. G is determining the index of refraction of sodium vapor for that portion of the spectrum which contains the sodium lines.

THE DEPARTMENT OF CHEMISTRY.

Mr. A is at present engaged upon a study of dissociation phenomena in the glycerine-glycol series, as well as in the sugar group.

Mr. B is making a study of equilibrium conditions in calomel vapor, and also between amorphous and soluble sulphur.

Mr. C is conducting two lines of work: (1) studies on molecular rearrangement, and of saponification and hydrolysis of organic compounds by physico-chemical and synthetic-organic methods; and (2) studies on the existence of positive halogen ions.

Mr. D is conducting work upon the dissociation constants of dibasic acids.

Mr. E upon the constitution of salts of organic cyanogen compounds.

Mr. F upon dialkyl derivatives of hydroxylamine.

THE DEPARTMENT OF GEOLOGY.

Mr. A is engaged in the investigation of the Kinderhook faunas of the Mississippi valley.

Mr. B is engaged upon the graphical expression of the chemical composition of igneous rocks, with reference to their mineral constitution and their classification.

Mr. C has under investigation the glaciation of the western mountains and the geology of the coastal plain.

Mr. D is working upon a group of problems relating to the origin and early stages of the earth and upon the system of dynamics connected therewith.

THE DEPARTMENT OF ZOOLOGY.

Mr. A is studying (1) the evolution of species as indicated in the genetic relations of color-patterns, voices, instincts, and general life-histories; (2) experiments in hybridizing species, to ascertain, if possible, general laws governing the transmission of hereditary characters, and the conditions necessary to creation of new species.

Mr. B (1) the method of evolution. The quantitative study of the changes that a species undergoes in different localities and in different geological periods at one locality. Illustrated by studies on the shells of the mollusk known as the 'scallop' (*Pecten*) from different points on the coast of North America and Europe and from fossil beds in Virginia.

Mr. C is working on problems in embryology: (1) the rôle of cell-division in development; the relation of the process of cleavage of the ovum to the formation of an embryo; (2) the investigation of the problem of correlative differentiation, *i. e.*, the influences exerted by parts of an embryo upon the development of other organs; more particularly, at present, the mechanics of development of the amnion in the chick; and allantois; and the influence of the nervous system in the formation of organs.

Mr. D is engaged in experimental study of problems connected with regeneration: (1) the factors influencing regeneration and the effect of altered conditions; (2) the differentiation of the regenerating structures and the differences between regenerated and original structures; (3) the physiology of form and form-regulation, *i. e.*, the return to normal or typical form, after experimental alteration of form and especially the effects of physical factors, *e. g.*, pressure, tension, etc., upon form in the lower invertebrates.

Mr. E is making experiments and statistical investigations of the relations existing between some of the factors of the environment, *i. e.*, temperature, humidity, food, topography, etc., and the production of variations in insects, especially in the color-patterns of coleoptera; (2) investigating the evolution of large genera and of groups of small genera, to determine if possible what causes are the dominant ones in the production of new races and species, and the conditions necessary for their preservation; based upon the experiments and statistics (1) and the ontogeny and phylogeny of color-patterns, color variations, and geographical distribution.

THE DEPARTMENT OF ANATOMY.

Mr. A is conducting research in problems of anatomy and pathology of the nervous system and in infectious diseases.

Mr. B has completed, since coming to the university, two papers: one on the structure of the cardiac glands of mammals; the other, the structure of Brunner's glands in mammals. He has under way three other researches: (1) on the structure of Paneth cells; (2) on the histology of the gastric glands of vertebrates; (3) on the structures of the human stomach. It is to be

noted that these researches deal with the finest structures of the digestive tract.

Mr. C has made extensive researches in general anatomy, especially in vertebrate embryology. His experiments on the formation of the embryo in fish and amphibia are well known. More recently he has taken up the study of histogenesis, especially of fibrillated muscle cells and their nuclei. At present he is engaged upon a study of spermolysins and ovolysins.

Mr. D has been making contributions to our knowledge of the anatomy of the spleen, especially its framework, but is better known through the work of the last year and a half, conducted chiefly with Professor Ehrlich in Frankfurt, upon the nature of poisons which act upon the blood, especially snake poison. His studies have attracted international attention and have a wide bearing upon blood poisons in general.

Mr. E has made a special study of the anatomy of the ducts and blood-vessels of the pancreas of the hog and their origin in the embryo and has published part of the results. He is now engaged upon the study of the framework and wandering cells of the mucous membrane of the human stomach.

Mr. F is engaged upon the study of the arrangement of the connective tissues in the mammalian larynx and the study of the histogenesis of the laryngeal glands in the pig.

Mr. G is engaged upon the study of the morphology of the head in vertebrates, and on the study of the changes in the structure of the mucous membrane of the stomach following the operation of gastroenterostomy.

Mr. H is making important observations in methods of staining nerves with methylene blue and with Bethe's neuro-fibril method. These studies have been concerned chiefly with the degeneration of axones and nerve endings after nerve section or local pressure; and further with the effect of electrical stimulation on the structure and vital staining properties of nerve endings.

Mr. J has worked out the distribution of the blood-vessels in the labyrinth of the ear of *Sus scrofa domesticus*, the results appearing in the Decennial Publications of the University. He is now engaged upon the study of the structure and function of the *stria vascularis*. He spent a great deal of time and care in the preparation of casts and injections to form material for his special course.

THE DEPARTMENT OF NEUROLOGY.

Mr. A is at work on the change in the percentage of water in the nervous system of the white rat during the period between birth and full maturity.

Mr. B is making a study of the relative activity of the white rat at different ages and at different hours of the day.

Mr. C is working on the effects of lecithin on the growth of the central nervous system.

Mr. D: on the law for the distribution of the nerve fibers which innervate the leg of the frog.

Mr. E: on an enumeration of the medullated nerve fibers in the dorsal and ventral roots of the spinal nerves of man.

Mr. F: on the psychical development of the young white rat correlated with the growth of its nervous system.

Miss G: on the mode in which the white substance of the spinal cord of the rat increases in area.

Mr. H: on the healing of wounds of the brain at different ages between birth and maturity.

Mr. J: on the axone reaction as observed in the nucleus of the third cranial nerve of the white rat.

THE DEPARTMENT OF BOTANY.

Mr. A is engaged in studying problems connected with the origin and evolution of seed plants. A book, just going through the press, for the first time organizes the subject for the benefit of advanced and research students.

Mr. B is at present investigating the problems of fertilization among the lower plants. The results are distinctly pushing out the boundaries of our knowledge of one of the most fundamental life-processes.

Mr. C is investigating cytological problems among plants, and is completing an important contribution to our knowledge of the methods of nuclear division.

Mr. D is a large contributor to plant ecology, and is now engaged in organizing the

subject for its first publication as a university text.

Mr. F has been investigating certain important problems presented by the club-mosses, among which the origin of the seed-habit is prominent.

Mr. G is engaged in investigating the causes of the forms assumed by plant bodies, as shown chiefly by lower plants. He has shown experimentally that form is in the main a phenomenon of chemistry and physics, and not to be explained by any mystical vitalistic theory.

Mr. H is investigating the ecological problems that underlie scientific forestry, his field of operations having been chiefly in the Rocky Mountains of Montana. He has just made an important report to the government on that region.

Mr. J has in preparation a book for students of plant physiology in which for the first time the subject will be considered from the standpoint of modern chemistry and physics.

THE DEPARTMENT OF BACTERIOLOGY.

Mr. A is engaged upon a study of some of the poisonous substances produced by bacteria, especially those that affect the red blood-corpuscles. He is also preparing evidence to be used in the suit between the states of Missouri and Illinois concerning the Chicago Drainage Canal.

Mr. B. has nearly completed a piece of work upon some disease-producing organisms found in human blood and closely related to the typhoid bacillus.

THE DEPARTMENT OF PALEONTOLOGY.

The work upon which Mr. A is at present engaged, and which will occupy the large part of the next two years, is a monographic study of the extinct orders of Mesozoic reptiles known as the Pterodactyls and Plesiosaurs. This investigation is aided by a grant from the Carnegie Museum.

Under the combined direction of Mr. A and Mr. B, and with Mr. C's cooperation, Mr. D, a fellow, is engaged upon a study of the fossil diptera of America, based chiefly upon a collection loaned to the Department by the U. S. National Museum.

THE SCHOOL OF GEOGRAPHY IN THE SUMMER SESSION OF CORNELL UNIVERSITY.

INTEREST in geography as a school subject has grown rapidly within the past ten years. Courses have multiplied in the summer sessions of the universities, and an increasing number of teachers in secondary and grade schools have awakened to their need of better training both in subject matter and in methods of treatment. More than a dozen of the larger universities now accept the subject for admission, and examinations are regularly offered by the College Entrance Examination Board.

These facts give special meaning to the organization of the Cornell School of Geography under the direction of Professor R. S. Tarr. Although following upon the discouraging typhoid epidemic of last winter, the health of the school was excellent, and the attendance much larger than was expected, including grade, normal and high school teachers and superintendents from seventeen states.

The courses and instructors were as follows: Physiography and geography of Europe, Professor R. S. Tarr; dynamic geology and geography of the United States, Professor Albert P. Brigham, of Colgate University; home geography and type studies in geography for grammar grades, Dr. Chas. A. McMurry, of Northern Illinois Normal School; commercial geography, Principal Philip Emerson, of Lynn; class-room problems and laboratory methods for the grades, Supervisor R. H. Whitebeck, of Trenton State Normal and Model Schools; laboratory in geography, Assistant Principal Frank Carney, of Ithaca; laboratory in geology, Mr. Geo. C. Matson, of Cornell University.

A large number of field excursions were made, in the vicinity of Ithaca, and to more remote points such as Watkins Glen, Lake Ontario and the coal region about Wilkesbarre. On one evening of each week a round table conference gave opportunity for informal dis-

cussion of school problems in geography and comparison from a wide range of experience.

It is expected that the school will be continued in 1904 with the same faculty. All the courses given this year, and some additional work, will be offered. A. P. B.

THE MALARIA EXPEDITION TO THE GAMBIA.

An abstract in *Nature* states that the Liverpool School of Tropical Medicine has issued a report on the prevention of malaria in the tropics with reference to the Gambia. Dr. Dutton, who conducted the expedition shows how a great deal of disease is due to the want of knowledge of the nature of malaria, and that during the dry season the residents are largely to blame for the appearance of the disease. The object of the expedition was to investigate the conditions under which mosquitoes were propagated in the town of Bathurst and at the principal stations of the colony, and to suggest methods of destroying these insects. Malaria was found to be prevalent in the colony; 80 per cent. of the native children examined harbored malaria parasites in their blood. The liability to infection of the Europeans commences soon after the rains are established, lasting up to the end of November. The various breeding places of mosquitoes are described in detail in chapter IV. of the report, particular mention being made of the wells, canoes, boats, lighters, cutters on the foreshore, and of the grass-clogged trenches in many of the streets, which together supply Bathurst with the majority of its mosquitoes during the wet season and for part of the dry season. The number of mosquito breeding places present in compounds was found to vary with the social position of the occupier. They increased in extent and number in proportion to the wealth and position of the occupier.

In one factory yard were found six barrels, and in the garden there were seventeen tubs and eight small wells, all breeding quantities of *Culex, Stegomyia,* and *Anopheles* mosquitoes. Besides these dry season breeding places, discarded domestic utensils were scattered about the yard and garden which, in the wet season, would have acted as breeding places. It is pointed out that during the dry season, from November to May, natural breeding places for mosquitoes in Bathurst cease to exist, and from this period the people breed mosquitoes solely in their own compounds.

In chapter V., which deals with the prevention of malaria in Bathurst, a campaign against the mosquito is advocated; the town is judged especially suitable for its success. Thus Bathurst is situated on a practically isolated piece of land surrounded on nearly all sides by a broad expanse of sea water. The amount of land to be dealt with is comparatively small, viz., about a square mile. The surface is fairly level, sandy, absorbing water readily. In this area the breeding places of mosquitoes are a known quantity, the artificial, or those made by man, being in excess of the natural. The rainfall is very small, and rain occurs only during four out of the twelve months of the year.

The probability of the introduction into Bathurst of yellow fever from Senegal is pointed out as another reason for attacking the mosquito. The expedition was informed by His Excellency, the acting Governor, H. M. Brandford Griffith, of the intention on the part of the Colonial Government to enter upon a crusade against the mosquito, and on November 18 the preliminary removal of rubbish from houses and compounds began; a sanitary inspector was appointed, and received special instruction in the work. Under him worked a gang of laborers, and at the time of the departure of the expedition (January 10) 363 houses and compounds had been inspected. From these 131 cartloads of old tin pots and other rubbish were removed. On the return of His Excellency the Governor, Sir George C. Denton, the inspector and a sufficient staff of laborers were appointed permanently, and a grant of £200 per annum was given for the special anti-mosquito work. Anti-mosquito regulations have been drawn up by the Colonial Government.

An appendix, by Mr. F. V. Theobald, is attached to the report; in it are described the various species of mosquitoes collected by the expedition, many of which were new to science.

SCIENTIFIC NOTES AND NEWS.

Dr. E. B. Copeland, instructor in bionomics, at Stanford University, has been appointed chief botanist of the United States Philippine Commission. A. D. E. Elmer, assistant in systematic botany, has been appointed assistant field collector on the same commission.

The British Rainfall Organization founded in 1860 by the late G. J. Symons, will henceforth be carried on under the sole charge of Dr. H. R. Mill, as Mr. Sowerby Wallis has been compelled by ill health to retire after more than thirty years connection with the association.

Jamaica has abandoned its weather service and Mr. Maxwell Hall, government meteorologist, has resigned the position which he has held since 1880. The compilation of the weather reports will hereafter be undertaken by the Chemists' Department.

The Hanbury Gold Medal of the Pharmaceutical Society of London has this year been awarded to M. Eugène Collin.

George Benjamin White (Ph.D. Yale) has been appointed assistant in the Department of Bacteriology, of the Hoagland Laboratory in Brooklyn.

Dr. Frank Russell has resigned the instructorship of anthropology at Harvard University, which he has held since 1897. Owing to his health, he will live on a ranch in Arizona.

Professor S. J. Barnett, of the Department of Physics of Stanford University, has returned from Alaska, where he had charge of a party, sent out by the U. S. Coast and Geodetic Survey.

Governor La Follette, of Wisconsin, has appointed a commission, consisting of Dr. Gustav Schmitt, Milwaukee, Professor H. L. Russell, bacteriologist at the State University, Madison, and Dr. M. R. Merrill, whose duty it is to determine the advisability of the establishment of a state hospital for the treatment of tuberculosis.

Secretary Wilson, of the Department of Agriculture, gave this week an address before the Irrigation Congress, meeting at Ogden, Utah.

President A. T. Hadley, of Yale University, was a passenger on the steamer *Prinzess Irene* which arrived at New York last week from Mediterranean ports.

Anton J. Carlson, Ph.D., of Stanford University, who was appointed research assistant by the Carnegie Institution last year, is now at San Diego doing research work in the temporary laboratory of the University of California. The subject of his investigations is 'the mechanism of the inhibition of the heart in invertebrates.'

During the past year Mr. T. W. Vaughan, of the United States Geological Survey, has devoted most of his time to a study of the later Tertiary corals of the United States and the West Indies. The manuscript of his monograph is far advanced and illustrations for sixty or seventy plates have been prepared.

Captain Lefant, of the French army, is about to explore the Niger Basin, under the auspices of the Paris Geographical Society and the French Colonial Office.

A bust in honor of the late Mr. W. Martindale will be unveiled at the London School of Pharmacy on October 1, when Dr. J. W. Swan, F.R.S., will make an address in connection with the opening of a new section of the school.

There has been unveiled at Langres, France, a monument in honor of the chemist, Laurent.

The deaths are announced of Dr. Eugen Askenasy, honorary professor of botany in the University of Heidelberg, at the age of fifty-eight years, of Dr. J. Lange, the mathematician, director of a Berlin Realgymnasium, at the age of fifty-seven years, and of Ernst Krause, who wrote on popular natural history under the name Carus Sterne, at the age of sixty-four years.

Mr. W. W. Astor has contributed $100,000 to the British Cancer Research Fund.

At the instance of Dr. N. L. Britton, director of the New York Botanical Garden,

the buildings at Cinchona relinquished by the government of Jamaica have been rented for a tropical botanical laboratory.

THE daily papers state that large crowds are visiting the American Museum of Natural History, New York, to see the specimen of radium there on exhibition, which was presented by Mr. Edward D. Adams.

THE Chemical Laboratory of the University Modena, including a scientific library containing 15,000 works, has been destroyed by fire.

THE Farmers' National Congress will hold its twenty-third annual session at Niagara Falls, beginning on September 22. Among the general addresses of scientific interest on the program are: 'Infectious and Contagious Diseases of Farm Animals and their effect on American Agriculture,' Dr. D. E. Salmon, Washington, D. C.; 'Insect Pests of Plants and their effect on American Agriculture,' Professor F. M. Webster, Urbana, Ill.

THE British *Journal of Education* states that the council of the Royal Geographical Society has at the request of the London School Board and the Oxford and Cambridge School Examinations Board drawn up syllabuses as guides to instruction in geography in elementary and in secondary schools. The elementary suggestions were drafted by the late Mr. T. G. Rooper, H.M.I.S., and, after his death, they were revised by Mr. G. G. Chisholm, M.A., B.Sc. The secondary were drafted by Mr. H. J. Mackinder.

THE British Government has appointed a commission to inquire into the alleged physical deterioration of the lower classes, with Mr. Almeric W. Fitzroy, clerk of the privy council, as chairman.

THE daily papers state that the legacy of M. de Pierrecourt, who left his money to the city of Rouen for the purpose of founding a family of giants, with a view to the physical regeneration of the human race, has been before the Council of State in Paris. An arrangement has been arrived at by which the city of Rouen undertakes to apply a sum of 800,000f. out of the testator's estate to the foundation of a useful institution, and to pay over the rest of the estate to M. de Pierrecourt's heirs.

CASES of illness including four deaths have occurred at Marseilles which are attributed to the plague, while in northern Mexico there is an outbreak of yellow fever, which is now being investigated by the Health Department of Texas.

THE U. S. Geological Survey has established seven new river stations and renewed four of the five old stations in North Dakota, so that eleven stations are now in operation in this state. The stations in the eastern part of the state have been established to determine the amount of water power available and for other general purposes. In the western part of the state, which is semi-arid, the stations have been established to determine the amount of water available for irrigation. This region has no large rivers except the Missouri, which has only a small fall, not so great as most irrigation canals. It is not probable, therefore, that this stream can be used for irrigation purposes until a later time, when the land shall have become more valuable. A thorough examination is being made of all the streams and the lands in North Dakota west of the Missouri River with a view to irrigation projects. If any project appears to be favorable, detailed surveys and estimates may be made, and, if the project is then found feasible, it will be recommended for construction. An examination is also being made of the cheap and abundant lignite resources of the state in the hope that lignite can be utilized for fuel in pumping water for irrigation in certain localities, where long canals would be impracticable.

THE London correspondent of the *Journal of the American Medical Association* calls attention to the statistics of the birth rate in Australia, recently collected by Mr. Coglan. The fall in the birth rate in Australia and New Zealand taken together is such that there are annually fewer births by nearly 20,000 than would have occurred if the rates prevailing as late as ten years ago had been maintained. New South Wales furnishes a stri-

king example. In 1887 there were in this state 112,247 married women under the age of 45; in 1901 there were 149,247, yet the number of children born was about the same in each year. The legitimate birth rate per 10,000 married women under the age of 45 is 239; in 1891 it was 276. A curious fact is that the decline occurs in every class, among people of every shade of opinion, except among women of Irish birth, who exhibit no decline. But as the proportion of women of Irish birth is fast decreasing that element in maintenance of the birth rate will soon disappear. Large as is the area of the Australian continent Mr. Coghlan thinks it is impossible that its people will become truly great under the conditions affecting the increase of population which now exist. Immigration has practically ceased to be an important factor, the maintenance and increase of the population depending on the birth rate alone—a rate seriously diminished and still diminishing.

UNIVERSITY AND EDUCATIONAL NEWS.

Professor F. D. Tucker, principal of the school of agriculture of the University of Minnesota, has been elected and has entered upon his duties as president of Memorial University, Mason City, Ia. This institution was founded about two years ago as a memorial to the Grand Army of the Republic. One building, the College of Arts, costing $100,000, has already been erected and will be occupied during the coming year.

University College, Reading, has received towards the cost of the new buildings £10,000 from Lady Wantage, widow of Lord Wantage, who was president of the college from 1896 to 1901; £10,000 from Mr. W. G. Palmer, M.P.; and a third £10,000 from three other contributors.

The Leeds Corporation technical instruction sub-committee, with the approval of the finance committee, has decided in the event of a charter being granted to the Yorkshire College, to give £4,000 a year towards the University funds, in addition to the £1,550 granted from the residue of the local taxation.

Dr. Burton D. Myers, assistant in anatomy at the Johns Hopkins University, has an appointment as instructor in anatomy in the Indiana State University.

Dr. C. H. Gordon, until recently superintendent of schools at Lincoln, Nebr., and instructor in geology and geography in the University of Nebraska, has been appointed acting-professor of geology in the University of Washington to take charge of the work of Professor Henry Landes, who has been granted a year's leave of absence for study in the University of Chicago.

The following is a list of appointments in the scientific departments of the University of Maine for the coming year: H. S. Boardman, B.C.E. and C.E., University of Maine, professor of civil engineering; W. N. Spring, B.A. and M.F., Yale, professor of forestry; W. D. Hurd, B.S., Michigan Agricultural College, professor of agriculture; A. W. Cole, B.S., Worcester Polytechnic Institute, instructor in shop-work; H. P. Hamlin, B.C.E., University of Maine, instructor in civil engineering; G. T. Davis, B.A., and J. B. Reed, B.A., of the University of Michigan, instructors in chemistry; E. H. Bowen, A.B., Colgate, tutor in physics; P. D. Simpson, B.S., University of Maine, tutor in civil engineering; R. M. Connor, B.S., University of Maine, tutor in mathematics; Edith M. Patch, A.B., University of Minnesota, entomologist in the experiment station; S. C. Dinsmore, B.S., University of Maine, assistant chemist in the experiment station.

Professor Authenrieth, of Freiburg, has been called to a professorship of chemistry in the University of Greifswald; Dr. Krigar-Menzel, docent in physics in the University of Berlin, has been appointed acting professor in the Technical Institute at Charlottenberg; Dr. Armin Tschermak, docent in physiology and assistant in the Physiological Institute of the University of Halle, has been promoted to a professorship, and Dr. Wilhelm Küster has been appointed professor of chemistry in the Veterinary School at Stuttgart.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, SEPTEMBER 25, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE INFLUENCE OF BRAIN-POWER ON HISTORY.

MY first duty to-night is a sad one. I have to refer to a great loss which this Nation and this Association have sustained. By the death of the great Englishman and great statesman who has just passed away, we members of the British Association are deprived of one of the most illustrious of our confrères. We have to mourn the loss of an enthusiastic student of science who conferred honor on our body by becoming its President. We recognize that as Prime Minister he was mindful of the interests of science, and that to him we owe a more general recognition on the part of the State of the value to the nation of the work of scientific men. On all these grounds you will join in the expression of respectful sympathy with Lord Salisbury's family in their great personal loss which your council has embodied this morning in a resolution of condolence.

Last year, when this friend of science ceased to be Prime Minister, he was succeeded by another statesman who also has given many proofs of his devotion to philosophical studies, and has shown in many utterances that he has a clear understanding of the real place of science in modern civilization. We then have good grounds

for hoping that the improvement in the position of science in this country which we owe to the one will also be the care of his successor, who has honored the Association by accepting the unanimous nomination of your council to be your President next year, an acceptance which adds a new lustre to this chair.

On this we may congratulate ourselves all the more because I think, although it is not generally recognized, that the century into which we have now well entered may be more momentous than any which has preceded it, and that the present history of the world is being so largely moulded by the influence of brain-power, which in these modern days has to do with natural as well as human forces and laws, that statesmen and politicians will have in the future to pay more regard to education and science, as empire-builders and empire-guarders, than they have paid in the past.

The nineteenth century will ever be known as the one in which the influences of science were first fully realized in civilized communities; the scientific progress was so gigantic that it seems rash to predict that any of its successors can be more important in the life of any nation.

Disraeli, in 1873, referring to the progress up to that year, spoke as follows: "How much has happened in these fifty years—a period more remarkable than any, I will venture to say, in the annals of mankind. I am not thinking of the rise and fall of Empires, the change of dynasties, the establishment of Governments. I am thinking of those revolutions of science which have had much more effect than any political causes, which have changed the position and prospects of mankind more than all the conquests and all the codes and all the legislators that ever lived."*

* *Nature*, November 27, 1873, Vol. IX., p. 71.

The progress of science, indeed, brings in many considerations which are momentous in relation to the life of any limited community—any one nation. One of these considerations to which attention is now being greatly drawn is that a relative decline in national wealth derived from industries must follow relative neglect of scientific education.

It was the late Prince Consort who first emphasized this when he came here fresh from the University of Bonn. Hence the 'Prince Consort's Committee,' which led to the foundation of the College of Chemistry and afterwards of the Science and Art Department. From that time to this the warnings of our men of science have become louder and more urgent in each succeeding year. But this is not all; the commercial output of one country in one century as compared with another is not alone in question; the acquirement of the scientific spirit and a knowledge and utilization of the forces of Nature are very much further reaching in their effects on the progress and decline of nations than is generally imagined.

Britain in the middle of the last century was certainly the country which gained most by the advent of science, for she was then in full possession of those material gifts of Nature, coal and iron, the combined winning and utilization of which, in the production of machinery and in other ways, soon made her the richest country in the world, the seat and throne of invention and manufacture, as Mr. Carnegie has called her. Being the great producers and exporters of all kinds of manufactured goods, we became eventually, with our iron ships, the great carriers, and hence the supremacy of our mercantile marine and our present command of the sea.

The most fundamental change wrought by the early applications of science was in

relation to producing and carrying power. With the winning of mineral wealth and the production of machinery in other countries, and cheap and rapid transit between nations, our superiority as depending upon first use of vast material resources was reduced. Science, which is above all things cosmopolitan—planetary, not national—internationalizes such resources at once. In every market of the world

> "things of beauty, things of use,
> Which one fair planet can produce,
> Brought from under every star,"

were soon to be found.

Hence the first great effect of the general progress of science was relatively to diminish the initial supremacy of Britain due to the first use of *material* resources, which indeed was the real source of our national wealth and place among the nations.

The unfortunate thing was that, while the foundations of our superiority depending upon our *material resources* were being thus sapped by a cause *which was beyond our control,* our statesmen and our universities were blind leaders of the blind, and our other asset, our mental resources, which was within our control, was culpably neglected.

So little did the bulk of our statesmen know of the part science was playing in the modern world and of the real basis of the nation's activities, that they imagined political and fiscal problems to be the only matters of importance. Nor, indeed, are we very much better off to-day. In the important discussions recently raised by Mr. Chamberlain, next to nothing has been said of the effect of the progress of science on prices. The whole course of the modern world is attributed to the presence or absence of taxes on certain commodities in certain countries. The fact that the great fall in the price of food-stuffs in England did not come till some thirty or forty years after the removal of the corn duty between 1847 and 1849 gives them no pause; for them new inventions, railways and steamships are negligible quantities; the vast increase in the world's wealth in free trade and protected countries alike comes merely according to them in response to some *political* shibboleth.

We now know, from what has occurred in other States, that if our Ministers had been more wise and our universities more numerous and efficient, our *mental resources* would have been developed by improvements in educational method, by the introduction of science into schools, and, more important than all the rest, by the teaching of science by experiment, observation and research, and not from books. It is because this was not done that we have fallen behind other nations in properly applying science to industry, so that our applications of science to industry are relatively less important than they were. But this is by no means all; we have lacked the strengthening of the national life produced by fostering the scientific spirit among all classes, and along all lines of the nation's activity; many of the responsible authorities know little and care less about science; we have not learned that it is the duty of a State to organize its forces as carefully for peace as for war; that universities and other teaching centres are as important as battleships or big battalions; are, in fact, essential parts of a modern State's machinery, and as such to be equally aided and as efficiently organized to secure its future well being.

Now the objects of the British Association as laid down by its founders seventy-two years ago are "To give a stronger impulse and a more systematic direction to scientific inquiry—to promote the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers—to obtain a more general attention to the ob-

jects of science and a removal of any disadvantages of a public kind which impede its progress.''

In the main, my predecessors in this chair, to which you have done me the honor to call me, have dealt, and with great benefit to science, with the objects first named.

But at a critical time like the present I find it imperative to depart from the course so generally followed by my predecessors and to deal with the last object named, for unless by some means or other we 'obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress,' we shall suffer in competition with other communities in which science is more generally utilized for the purposes of the national life.

THE STRUGGLE FOR EXISTENCE IN MODERN COMMUNITIES.

Some years ago, in discussing the relations of scientific instruction to our industries, Huxley pointed out that we were in presence of a new 'struggle for existence,' a struggle which, once commenced must go on until only the fittest survives.

It is a struggle between organized species —nations—not between individuals or any class of individuals. It is, moreover, a struggle in which science and brains take the place of swords and sinews, on which depended the result of those conflicts which, up to the present, have determined the history and fate of nations. The school, the university, the laboratory and the workshop are the battlefields of this new warfare.

But it is evident that if this, or anything like it, be true, our industries cannot be involved alone; the scientific spirit, brain-power, must not be limited to the workshop if other nations utilize it in all branches of their administration and executive.

It is a question of an important change of front. It is a question of finding a new basis of stability for the Empire in face of new conditions. I am certain that those familiar with the present states of things will acknowledge that the Prince of Wales's call, 'Wake up,' applies quite as much to the members of the Government as it does to the leaders of industry.

What is wanted is a complete organization of the resources of the nation, so as to enable it best to face all the new problems which the progress of science, combined with the ebb and flow of population and other factors in international competition, are ever bringing before us. Every Minister, every public department, is involved, and this being so, it is the duty of the whole nation—King, Lords, and Commons—to do what is necessary to place our scientific institutions on a proper footing in order to enable us to 'face the music' whatever the future may bring. The idea that science is useful only to our industries comes from want of thought. If anyone is under the impression that Britain is only suffering at present from the want of the scientific spirit among our industrial classes, and that those employed in the State service possess adequate brain-power and grip of the conditions of the modern world into which science so largely enters, let him read the report of the Royal Commission on the War in South Africa. There he will see how the whole 'system' employed was, in Sir Henry Brackenbury's words applied to a part of it, *'unsuited to the requirements of an Army which is maintained to enable us to make war.'* Let him read also, in the address of the president of the Society of Chemical Industry what drastic steps had to be taken by Chambers of Commerce and 'a quarter of a million of working men' to get the Patent Law Amendment Act into proper shape, in spite of all the advisers and officials of the Board of Trade. Very

few people realize the immense number of scientific problems the solution of which is required for the State service. The nation itself is a gigantic workshop, and the more our rulers and legislators, administrators and executive officers possess the scientific spirit, the more the rule of thumb is replaced in the State service by scientific methods, the more able shall we be, thus armed at all points, to compete successfully with other countries along all lines of national as well as of commercial activity.

It is obvious that the power of a nation for war, in men and arms and ships, is one thing; its power in the peace struggles to which I have referred is another; in the latter, the source and standard of national efficiency are entirely changed. To meet war conditions, there must be equality or superiority in battleships and army corps. To meet the new peace conditions there must be equality or superiority in universities, scientific organization and everything which conduces to greater brain power.

OUR INDUSTRIES ARE SUFFERING IN THE PRESENT INTERNATIONAL COMPETITION.

The present condition of the nation, so far as its industries are concerned, is as well known, not only to the Prime Minister, but to other political leaders in and out of the Cabinet, as it is to you and to me. Let me refer to two speeches delivered by Lord Rosebery and Mr. Chamberlain on two successive days in January, 1901:

Lord Rosebery spoke as follows:

"* * * The war I regard with apprehension is the war of trade which is unmistakably upon us. * * * When I look round me I cannot blind my eyes to the fact that so far we can predict anything of the twentieth century on which we have now entered, it is that it will be one of acutest international conflict in point of trade. We were the first nation of the modern world to discover that trade was an absolute necessity. For that we were nicknamed a nation of shopkeepers; but now every nation wishes to be a nation of shopkeepers, too, and I am bound to say that when we look at the character of some of these nations, and when we look at the intelligence of their preparations, we may well feel that it behooves us not to fear, but to gird up our loins in preparation for what is before us."

Mr. Chamberlain's views were stated in the following words:

"I do not think it is necessary for me to say anything as to the urgency and necessity of scientific training. * * * It is not too much to say that the existence of this country, as the great commercial nation, depends upon it. * * * It depends very much upon what we are doing now, at the beginning of the twentieth century, whether at its end we shall continue to maintain our supremacy or even equality with our great commercial and manufacturing rivals."

All this refers to our industries. We are not suffering because trade no longer follows the flag as in the old days, but because trade follows the brains, and our manufacturers are too apt to be careless in securing them. In one chemical establishment in Germany, 400 doctors of science, the best the universities there can turn out, have been employed at different times in late years. In the United States the most successful students in the higher teaching centers are snapped up the moment they have finished their course of training, and put into charge of large concerns, so that the idea has got abroad that youth is the password of success in American industry. It has been forgotten that the latest product of the highest scientific education must necessarily be young, and that it is the training and not the age

which determines his employment. In Britain, on the other hand, apprentices who can pay high premiums are too often preferred to those who are well educated, and the old rule-of-thumb processes are preferred to new developments—a conservatism too often depending upon the master's own want of knowledge.

I should not be doing my duty if I did not point out that the defeat of our industries one after another, concerning which both Lord Rosebery and Mr. Chamberlain express their anxiety, is by no means the only thing we have to consider. The matter is not one which concerns our industrial classes only, for knowledge must be pursued for its own sake, and since the full life of a nation with a constantly increasing complexity, not only of industrial, but of high national aims, depends upon the universal presence of the scientific spirit—in other words, brain power—our whole national life is involved.

THE NECESSITY FOR A BODY DEALING WITH THE ORGANIZATION OF SCIENCE.

The present awakening in relation to the nation's real needs is largely due to the warnings of men of science. But Mr. Balfour's terrible Manchester picture of our present educational condition * shows that the warning which has been going on now for more than fifty years has not been forcible enough; but if my contention that other reorganizations besides that of our education are needed is well founded, and if men of science are to act the part of good citizens in taking their share in endeavoring to bring about a better state of things, the question arises, has the neglect of their warnings so far been due to the way in which these have been given?

Lord Rosebery, in the address to a Chamber of Commerce from which I have already quoted, expressed his opinion that such bodies do not exercise so much influence as might be expected of them. But if commercial men do not use all the power their organization provides, do they not by having built up such an organization put us students of science to shame, who are still the most disorganized members of the community?

Here, in my opinion, we have the real reason why the scientific needs of the nation fail to command the attention either of the public or of successive governments. At present, appeals on this or on that behalf are the appeals of individuals; science has no collective voice on the larger national questions; there is no organized body which formulates her demands.

During many years it has been part of my duty to consider such matters, and I have been driven to the conclusion that our great crying need is to bring about an organization of men of science and all interested in science, similar to those which prove so effective in other branches of human activity. For the last few years I have dreamt of a Chamber, Guild, League, call it what you will, with a wide and large membership, which should give us what, in my opinion, is so urgently needed. Quite recently I sketched out such an organization, but what was my astonishment to find that I had been forestalled, and by the founders of the British Association!

THE BRITISH ASSOCIATION SUCH A BODY.

At the commencement of this address I pointed out that one of the objects of the Association, as stated by its founders, was 'to obtain a more general attention to the objects of science and a removal of any

* "The existing educational system of this country is chaotic, is ineffectual, is utterly behind the age, makes us the laughing-stock of every advanced nation in Europe and America, puts us behind, not only our American cousins, but the German and the Frenchman and the Italian."—*Times*, October 15, 1902.

disadvantages of a public kind which impede its progress.'

Everyone connected with the British Association from its beginning may be congratulated upon the magnificent way in which the other objects of the Association have been carried out, but as one familiar with the Association for the last forty years, I cannot but think that the object to which I have specially referred has been too much overshadowed by the work done in connection with the others.

A careful study of the early history of the Association leads me to the belief that the function I am now dwelling on was strongly in the minds of the founders; but be this as it may, let me point out how admirably the organization is framed to enable men of science to influence public opinion and so to bring pressure to bear upon Governments which follow public opinion. (1) Unlike all the other chief metropolitan societies, its outlook is not limited to any branch or branches of science. (2) We have a wide and numerous fellowship, including both the leaders and the lovers of science, in which all branches of science are and always have been included with the utmost catholicity—a condition which renders strong committees possible on any subject. (3) An annual meeting at a time when people can pay attention to the deliberations, and when the newspapers can print reports. (4) The possibility of beating up recruits and establishing local committees in different localities, even in the King's dominions beyond the seas, since the place of meeting changes from year to year, and is not limited to these islands.

We not only, then, have a scientific parliament competent to deal with all matters, including those of national importance, relating to science, but machinery for influencing all new councils and committees dealing with local matters, the functions of which are daily becoming more important.

The machinery might consist of our corresponding societies. We already have affiliated to us seventy societies with a membership of 25,000; were this number increased so as to include every scientific society in the Empire, metropolitan and provincial, we might eventually hope for a membership of half a million.

I am glad to know that the Council is fully alive to the importance of giving impetus to the work of the corresponding societies. During this year a committee was appointed to deal with the question; and later still, after this committee had reported, a conference was held between this committee and the corresponding societies committee to consider the suggestions made, some of which will be gathered from the following extract:

"In view of the increasing importance of science to the nation at large, your committee desire to call the attention of the council to the fact that in the corresponding societies the British Association has gathered in the various centres represented by these societies practically all the scientific activity of the provinces. The number of members and associates at present on the list of the corresponding societies approaches 25,000, and no organization is in existence anywhere in the country better adapted than the British Association for stimulating, encouraging and coordinating all the work being carried on by the seventy societies at present enrolled. Your committee are of opinion that further encouragement should be given to these societies and their individual working members by every means within the power of the association; and with the object of keeping the corresponding societies in more permanent touch with the Association they suggest that an official invitation on behalf of the Council be addressed to the societies through the corresponding societies committee asking them to appoint standing

British Association sub-committees, to be elected by themselves with the object of dealing with all those subjects of investigation common to their societies and to the British Association committees, and to look after the general interests of science and scientific education throughout the provinces and provincial centers. * * *

"Your committee desire to lay special emphasis on the necessity for the extension of the scientific activity of the corresponding societies and the expert knowledge of many of their members in the direction of scientific education. They are of opinion that immense benefit would accrue to the country if the corresponding societies would keep this requirement especially in view with the object of securing adequate representation for scientific education on the Education Committees now being appointed under the new Act. The educational section of the Association having been but recently added, the corresponding societies have as yet not had much opportunity for taking part in this branch of the Association's work; and in view of the reorganization in education now going on all over the country your committee are of opinion that no more opportune time is likely to occur for the influence of scientific organizations to make itself felt as a real factor in national education. * * *"

I believe that if these suggestions or anything like them—for some better way may be found on inquiry—are accepted, great good of science throughout the Empire will come. Rest assured that sooner or later such a guild will be formed because it is needed. It is for you to say whether it shall be, or form part of, the British Association. We in this Empire certainly need to organize science as much as in Germany they find the need to organize a navy. The German Navy League, which has branches even in our Colonies, already has a membership of 630,000, and its income is nearly 20,000*l*. a year. A British Science League of 500,000 with a sixpenny subscription would give us 12,000*l*. a year, quite enough to begin with.

I for one believe that the British Association would be a vast gainer by such an expansion of one of its existing functions. Increased authority and prestige would follow its increased utility. The meetings would possess a new interest; there would be new subjects for reports; missionary work less needed than formerly would be replaced by efforts much more suited to the real wants of the time. This magnificent, strong and complicated organization would become a living force, working throughout the year, instead of practically lying idle, useless and rusting for 51 weeks out of the 52 so far as its close association with its members is concerned.

If this suggestion in any way commends itself to you, then when you begin your work in your sections or general committee see to it that a body is appointed to inquire how the thing can be done. Remember that the British Association will be as much weakened by the creation of a new body to do the work I have shown to have been in the minds of its founders as I believe it will be strengthened by becomong completely effective in every one of the directions they indicated, and for which effectiveness we their successors are indeed responsible. The time is appropriate for such a reinforcement of one of the wings of our organization, for we have recently included Education among our sections.

There is another matter I should like to see referred to the committee I have spoken of, if it please you to appoint it. The British Association, which as I have already pointed out is now the chief body in the Empire which deals with the totality of science, is, I believe, the only organiza-

tion of any consequence which is without a charter, and which has not His Majesty the King as patron.

THE FIRST WORK OF SUCH AN ORGANIZATION.

I suppose it is my duty after I have suggested the need of organization to tell you my personal opinion as to the matters where we suffer most in consequence of our lack of organization at the present time.

Our position as a nation, our success as merchants, are in peril chiefly—dealing with preventable causes—because of our lack of completely efficient universities, and our neglect of research. This research has a double end. A professor who is not learning can not teach properly or arouse enthusiasm in his students; while a student of any thing who is unfamiliar with research methods, and without that training which research brings, will not be in the best position to apply his knowledge in after life. From neglect of research comes imperfect education and a small output of new applications and new knowledge to reinvigorate our industries. From imperfect education comes the unconcern touching scientific matters, and the too frequent absence of the scientific spirit, in the nation generally from the court to the parish council.

I propose to deal as briefly as I can with each of these points.

UNIVERSITIES.

I have shown that so far as our industries are concerned, the cause of our failure has been run to earth; it is fully recognized that it arises from the insufficiency of our universities both in numbers and efficiency, so that not only our captains of industry, but those employed on the nation's work generally, do not secure a training similar to that afforded by other nations. No additional endowment of primary, secondary or technical instruction will mend matters. This is not merely the opinion of men of science; our great towns know it, our Ministers know it.

It is sufficient for me to quote Mr. Chamberlain:—

"It is not everyone who can, by any possibility, go forward into the higher spheres of education; but it is from those who do that we have to look for the men who, in the future, will carry high the flag of this country in commercial, scientific and economic competition with other nations. At the present moment, I believe there is nothing more important than to supply the deficiences which separate us from those with whom we are in the closest competition. In Germany, in America, in our own colony of Canada and in Australia, the higher education of the people has more support from the Government, is carried further, than it is here in the old country; and the result is that in every profession, in every industry, you find the places taken by men and by women who have had a university education. And I would like to see the time in this country when no man should have a chance for any occupation of the better kind, either in our factories, our workshops or our counting-houses, who could not show proof that, in the course of his university career, he had deserved the position that was offered to him. What is it that makes a country? Of course you may say, and you would be quite right, 'The general qualities of the people, their resolution, their intelligence, their pertinacity, and many other good qualities.' Yes; but that is not all, and it is not the main creative feature of a great nation. The greatness of a nation is made by its greatest men. It is those we want to educate. It is to those who are able to go, it may be, from the very lowest steps in the ladder, to men who are able to devote their

time to higher education, that we have to look to continue the position which we now occupy as, at all events, one of the greatest nations on the face of the earth. And, feeling as I do on these subjects, you will not be surprised if I say that I think the time is coming when Governments will give more attention to this matter, and perhaps find a little more money to forward its interests'' (*Times,* November 6, 1902).

Our conception of a university has changed. University education is no longer regarded as the luxury of the rich which concerns only those who can afford to pay heavily for it. The Prime Minister in a recent speech, while properly pointing out that the collective effect of our public and secondary schools upon British character can not be overrated, frankly acknowledged that the boys of seventeen or eighteen who have to be educated in them 'do not care a farthing about the world they live in except in so far as it concerns the cricket-field or the football-field or the river.' On this ground they are not to be taught science, and hence, when they proceed to the university, their curriculum is limited to subjects which were better taught before the modern world existed, or even Galileo was born. But the science which these young gentlemen neglect, with the full approval of their teachers, on their way through the school and the university to politics, the Civil Service, or the management of commercial concerns, is now one of the great necessities of a nation, and our universities must become as much the insurers of the future progress as battleships are the insurers of the present power of States. In other words, university competition between States is now as potent as competition in building battleships, and it is on this ground that our university conditions become of the highest national concern and, therefore, have to be referred to here, and all the more because our industries are not alone in question.

WHY WE HAVE NOT MORE UNIVERSITIES.

Chief among the causes which have brought us to the terrible condition of inferiority as compared with other nations in which we find ourselves are our carelessness in the matter of education and our false notions of the limitations of State functions in relation to the conditions of modern civilization.

Time was when the Navy was largely a matter of private and local effort. William the Conqueror gave privileges to the Cinque Ports on the condition that they furnished fifty-two ships when wanted. In the time of Edward III., of 730 sail engaged in the siege of Calais, 705 were 'people's ships.'' All this has passed away; for our first line of defence we no longer depend on private and local effort.

Time was when not a penny was spent by the State on elementary education. Again, we no longer depend upon private and local effort. The navy and primary education are now recognized as properly calling upon the public for the necessary financial support. But when we pass from primary to university education, instead of State endowment we find State neglect; we are in a region where it is nobody's business to see that anything is done.

We in Great Britain have thirteen universities competing with 134 State and privately endowed in the United States and twenty-two State endowed in Germany. I leave other countries out of consideration for lack of time, and I omit all reference to higher institutions for technical training, of which Germany alone possesses nine of university rank, because they are less important; they instruct rather than educate, and our want is education. The German State gives to one university more than the British Government allows to all the

universities and university colleges in England, Ireland, Scotland, and Wales put together. These are the conditions which regulate the production of brain-power in the United States, Germany, and Britain respectively, and the excuse of the Government is that this is a matter for private effort. Do not our Ministers of State know that other civilized countries grant efficient State aid, and further, that private effort has provided in Great Britain less than 10 per cent. of the sum thus furnished in the United States in addition to State aid? Are they content that we should go under in the great struggle of the modern world because the Ministers of other States are wiser, and because the individual citizens of another country are more generous, than our own?

If we grant that there was some excuse for the State's neglect so long as the higher teaching dealt only with words, and books alone had to be provided (for the streets of London and Paris have been used as class rooms at a pinch), it must not be forgotten that during the last hundred years not only has knowledge been enormously increased, but things have replaced words, and fully equipped laboratories must take the place of books and class rooms if university training worthy of the name is to be provided. There is much more difference in size and kind between an old and new university than there is between the old caravel and a modern battleship, and the endowments must follow suit.

What are the facts relating to private endowment in this country? In spite of the munificence displayed by a small number of individuals in some localities, the truth must be spoken. In depending in our country upon this form of endowment, we are trusting to a broken reed. If we take the twelve English university colleges, the forerunners of universities unless we are to perish from lack of knowledge, we find that private effort during sixty years has found less than 4,000,000*l.*, that is, 2,000,000*l.* for buildings and 40,000*l.* a year income. This gives us an average of 166,000*l.* for buildings and 3,300*l.* for yearly income.

What is the scale of private effort we have to compete with in regard to the American universities?

In the United States, during the last few years, universities and colleges have received more than 40,000,000*l.* from this source alone; private effort supplied nearly 7,000,000*l.* in the years 1898–1900.

Next consider the amount of State aid to universities afforded in Germany. The buildings of the new University of Strassburg have already cost nearly a million; that is, about as much as has yet been found by private effort for buildings in Manchester, Liverpool, Birmingham, Bristol, Newcastle and Sheffield. The Government annual endowment of the same German university is more than 49,000*l.*

This is what private endowment does for us in England, against State endowment in Germany.

But the State does really concede the principle; its present contribution to our universities and colleges amounts to 155,600*l.* a year; no capital sum, however, is taken for buildings. The State endowment of the University of Berlin in 1891–2 amounted to 168,777*l.*

When, then, we consider the large endowments of university education both in the United States and Germany, it is obvious that State aid only can make any valid competition possible with either. The more we study the facts, the more statistics are gone into, the more do we find that we, to a large extent, lack both of the sources of endowment upon one or other or both of which other nations depend. We are between two stools, and the prospect is hopeless without some drastic changes. And first among these, if we intend to get out of the present slough of despond, must be

the giving up of the idea of relying upon private effort.

That we lose most where the State does least is known to Mr. Chamberlain, for in his speech, to which I have referred, on the University of Birmingham, he said: "As the importance of the aim we are pursuing becomes more and more impressed upon the minds of the people, we may find that we shall be more generously treated by the State."

Later still, on the occasion of a visit to University College School, Mr. Chamberlain spoke as follows:

"When we are spending, as we are, many millions—I think it is 13,000,000*l.*—a year on primary education, it certainly seems as if we might add a little more, even a few tens of thousands, to what we give to University and secondary education" (*Times*, November 6, 1902).

To compete on equal grounds with other nations we must have more universities. But this is not all—we want a far better endowment of all the existing ones, not forgetting better opportunities for research on the part of both professors and students. Another crying need is that of more professors and better pay. Another is the reduction of fees; they should be reduced to the level in those countries which are competing with us, to say, one-fifth of their present rates, so as to enable more students in the secondary and technical schools to complete their education.

In all these ways, facilities would be afforded for providing the highest instruction to a much greater number of students. At present there are almost as many *professors and instructors* in the universities and colleges of the United States as there are *day students* in the universities and colleges of the United Kingdom.

Men of science, our leaders of industry, and the chiefs of our political parties all agree that our present want of higher education—in other words, properly equipped universities—is heavily handicapping us in the present race for commercial supremacy, because it provides a relatively inferior brain-power which is leading to a relatively reduced national income.

The facts show that in this country we can not depend upon private effort to put matters right. How about local effort?

Anyone who studies the statistics of modern municipalities will see that it is impossible for them to raise rates for the building and upkeep of universities.

The buildings of the most modern university in Germany have cost a million. For upkeep the yearly sums found, chiefly by the State, for German universities of different grades, taking the incomes of seven out of the twenty-two universities as examples, are:

		£
1st Class	Berlin	130,000
2nd Class	Bonn, Göttingen	56,000
3rd Class	Königsberg, Strassburg	48,000
4th Class	Heidelberg, Marburg	37,000

Thus if Leeds, which is to have a university, is contene with the 4th class German standard, a rate must be levied of 7*d.* in the pound for yearly expenses, independent of all buildings. But the facts are that our towns are already at the breaking strain. During the last fifty years, in spite of enormous increases in rateable values, the rates have gone up from about 2*s.* to about 7*s.* in the pound for real *local* purposes. But no university can be a merely local institution.

NORMAN LOCKYER.

(*To be concluded.*)

MENDEL'S LAW OF HEREDITY.*

WHAT will doubtless rank as one of the great discoveries in biology, and in the

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study of heredity perhaps the greatest, was made by Gregor Mendel, an Austrian monk, in the garden of his cloister, some forty years ago. The discovery was announced in the proceedings of a fairly well-known scientific society, but seems to have attracted little attention and to have been soon forgotten. The Darwinian theory then occupied the center of the scientific stage and Mendel's brilliant discovery was all but unnoticed for a third of a century. Meanwhile the discussion aroused by Weismann's germ-plasm theory, in particular the idea of the non-inheritance of acquired characters, had put the scientific public into a more receptive frame of mind. Mendel's law was rediscovered independently by three different botanists engaged in the study of plant-hybrids—de Vries, Correns and Tschermak—in the year 1900. It remained, however, for a zoologist, Bateson, two years later, to point out the full importance and the wide applicability of the law. Since then the Mendelian discoveries have attracted the attention of biologists generally. Accordingly a brief statement of their underlying principles may not be without interest to others also.

1. *The Law of Dominance.*—When mating occurs between two animals or plants differing in some character, the offspring frequently all exhibit the character of one parent only, in which case that character is said to be '*dominant.*' Thus, when white mice are crossed with gray mice, all the offspring are gray, that color character being dominant. The character which is not seen in the immediate offspring is called '*recessive,*' for though unseen it is still present in the young, as we shall see. White, in the instance given, is the recessive character. The principle of heredity just stated may be called *the law of dominance.* The first instance of it discovered by Mendel related to the cotyledon-color in peas obtained by crossing different garden varieties. Yellow color of cotyledons was found to be dominant over green; likewise, round smooth form of seed was found to be dominant over angular wrinkled form; and violet color of blossoms, over white color. Other illustrations might be mentioned both among animals and among plants, but these will suffice.

2. *Peculiar Hybrid Forms.*—The law of dominance is not of universal applicability; Mendel does not so declare, though some of his critics have thus interpreted him. In many cases the cross-bred offspring possess a character intermediate between those of the parents. This Mendel found to be true when varieties of peas differing in height were crossed.

Again, the cross-breds may possess what appears to be *an intensification of the character of one parent,* as when in crossing dwarf with tall peas the hybrid plant is *taller than either parent,* or as when, in crossing a brown-seeded with a white-seeded variety of bean, the offspring bear beans of a darker brown than those of the brown-seeded parent.

Thirdly, the cross-bred may have a character entirely different from that of either parent. Thus a cross between spotted, black-and-white mice, and albino mice, produces commonly mice entirely gray in color, like the house-mouse. Again, in crossing beans, a variety having yellowish-brown seeds crossed with a white-seeded variety yields sometimes black-mottled seed, a character possessed by neither parent.

These three conditions may be grouped together by saying—the hybrid often possesses *a character of its own,* instead of the pure character of one parent, as is true in cases of complete dominance. The hybrid character may approximate that of one parent or the other, or it may be different from both. There is no way of predicting

what the hybrid character in a given cross will be. It can be determined only by experiment, but it is always the same for the same cross, provided the parents are pure. Often the hybrid form resembles a supposed ancestral condition, in which case it is commonly designated a reversion. Illustrations are the gray hybrid mice, which are indistinguishable in appearance from the house-mouse, and slate-colored pigeons resulting from crossing white with buff pigeons.

3. *Purity of the Germ-cells.*—The great discovery of Mendel is this: *The hybrid, whatever its own character, produces ripe germ-cells which bear only the pure character of one parent or the other.* Thus, when one parent has the character A, and the other the character B, the hybrid will have the character AB, or in cases of simple dominance, A(B)* or B(A). But whatever the character of the hybrid may be, its germ-cells, when mature, will bear *either the character A or the character B, but not both;* and As and Bs will be produced *in equal numbers.* This perfectly simple principle is known as the law of '*segregation,*' or the law of the 'purity of the germ-cells.' It bids fair to prove as fundamental to a right understanding of the facts of heredity as is the law of definite proportions in chemistry. From it follow many important consequences.

A first consequence of the law of purity of the germ-cells is polymorphism of the second and later hybrid generations. The individuals of the first hybrid generation are all of one type, provided the parent individuals were pure. Each has a character resulting from the combination of an A with a B, let us say AB. [In cases of dominance it would more properly be expressed by A (B) or B (A).] But in the next generation three sorts of combinations

* The parenthesis is used to indicate a recessive character not *visible* in the individual.

are possible, since each parent will furnish As and Bs in equal numbers. The possible combinations are AA, AB and BB. The first sort will consist of pure As and will breed true to that character ever afterward, unless crossed with individuals having a different character. Similarly, the third sort will consist of pure Bs and will breed true to that character. But the second sort, AB, will consist of hybrid individuals, like those of which the first hybrid generation was exclusively composed. If, as supposed, germ-cells, A and B, are produced in equal numbers by hybrids of both sexes, and unite at random in fertilization, combinations AA, AB and BB should occur in the frequencies, 1:2:1. For in unions between two sets of gametes, each A+B, there is one chance each for the combinations AA and BB, but two chances for the combination AB.

If the three forms AA (or simply A), AB and B are all different in appearance, it will be a very simple matter in an experiment to count those of each class and determine whether they occur in the theoretical proportions, 1:2:1. One such case has been observed by Bateson (:**02**, p. 183) among Chinese primroses (*Primula sinensis*). An unfixable hybrid variety known as 'giant lavender,' bearing flowers of a lavender color, was produced by crossing

TABLE I.

Characters, ⟶	A.	AB.	B.
Plants bearing Flowers in Color	Magenta Red.	Lavender.	White.
1901, Lot 1	19	27	14
1901, Lot 2	9	20	9
1902, Lot 1	12	23	11
1902, Lot 2	14	26	11
Totals	54	96	45
Per cent. of whole	29	49+	22

a magenta red with a white flowering variety tinged faintly with pink. By seed the hybrid constantly produces plants

bearing magenta red and white flowers respectively as well as other plants bearing lavender flowers. The numerical proportions observed in two successive seasons are shown in Table I. The observed numbers, it will be seen, are quite close to the theoretical 1 : 2 : 1.

In cases wherein the hybrid is indistinguishable from one of the parent forms, *i. e.*, in cases of complete dominance of

TABLE II.

Heredity of Cotyledon-color among Cross-bred Peas.

Parents Crossed.	Offspring. Gen. I.	Gen. II.	Gen. III.	Gen. IV.
G	Y(G)	1G.........	G.........	...G
		3 { 2Y(G)	1G.........	...G
			3 { 2Y(G)	
			1Y.....	...Y
Y		1Y.....	......Y.....	...Y

one parental character, only two categories of offspring will be recognizable and these will be numerically as 3 : 1. But further breeding will allow the separation of the larger group into two subordinate classes—first, individuals bearing only the dominant character; secondly, hybrids; that is, into groups A and A(B), which will be numerically as 1 : 2.

Observed results are in this case also very close to theory. Mendel, by crossing yellow with green peas, obtained, as we have seen, only yellow (hybrid) seed. Plants raised from this seed bore in the same pods both yellow seed and green seed in the ratio 3 : 1. (See Table II.) Under self-fertilization, the green seed produced in later generations green seed only. It bore only the recessive character. Of the yellow seeds, one in three produced only yellow offspring, *i. e.*, contained only the dominant character; but two out of three proved to be hybrid, producing both green and yellow seed, as did the hybrids of the preceding generation. These are precisely the theoretical proportions, A + 2 A(B) + B.

In the case of mice, it has been shown independently by Cuenot ('02) and by the writer's pupil, Mr. G. M. Allen, that the second hybrid generation, obtained by crossing gray with white mice, consists of gray mice and white mice approximately in the ratio 3 : 1. (See Table III.) The white are pure recessives, producing only white offspring, when bred *inter se*. What portion of the grays are pure dominants has not yet been determined with precision, but we may confidently expect that it will prove to be not far from 1 in 3.

TABLE III.

Heredity of Coat-color among Cross-bred Mice obtained by Mating White Mice (W) with Gray Mice (G).

Parents Crossed.	Offspring. Gen. I.	Gen. II.	Gen. III.
W	G(W)	1W............	...W
		3 { 2G(W)	1W
			3 { 2G(W)
			1G
G		1G.........	...G

A further test of the correctness of Mendel's hypothesis of the purity of the germ-cells and of their production in equal numbers, is afforded by back-crossing of a hybrid with one of the parental forms. For example, take a case of simple dominance, as of cotyledon-color in peas or coat-color in mice. We have here characters D (dominant) and R (recessive). The first generation hybrids will all be D(R). Any one of them back-crossed with the recessive parent will produce fifty per cent. of pure recessive offspring and fifty per cent. of hybrids.

For the hybrid produces germ-cells	D + R
The recessive parent produces germ-cells	R + R
The possible combinations are....	2D(R) + 2R

This case has been tested for peas and for mice and found to be substantially as stated.

We have thus far considered only cases of cross-breeding between parents differing in a single character. We have seen that in such cases, no new forms, except the unstable hybrid form, are produced. But when the parent forms crossed differ in two or more characters, there will be produced in the second and later hybrid generations individuals possessing *new combinations* of the characters found in the parents; indeed, *all possible combinations* of those characters will be formed, and in the proportions demanded by chance. Thus when parents are crossed which differ in *two* respects, A and B, let us designate the dominant phase of these characters by A, B, the recessive phase by a, b. The immediate offspring resulting from the cross will all be alike, AB(ab),* but the second and later generations of hybrids will contain the stable, *i. e.*, pure classes, AB, Ab, aB, ab, in addition to other (unstable or still hybrid) forms, namely, AB(ab), AB(b), A(a)B, A(a)b and aB(b). In every sixteen second-generation offspring there will be, on the average, one representing each of the stable combinations. Two of the stable combinations will be identical with the parent forms, the other two will be new. The remaining twelve individuals will be hybrid in one or both characters.

An illustration may help to make this case clear. Among domesticated guinea-pigs, as among mice and rabbits, albinism is recessive with respect to pigmented coat. Further, there occur among guinea-pigs individuals known as 'Abyssinians,' whose coat presents a curious rough appearance, for the reason that the hair stands out stiffly from the body in a number of 'cow-licks' or rosettes. In crosses the Abyssinian or rough coat regularly dominates over the normal or smooth coat. Now let us consider what happens when a cross is made involving both these pairs of Mendelian characters, albinism *vs.* pigmented coat, and smooth *vs.* rough coat. If a white Abyssinian is bred to a pigmented smooth guinea-pig, the young are without exception *pigmented* and *rough,* these being the *dominant* members of the two pairs of characters. But the young of course contain in a latent condition the two recessive characters, white coat and smooth coat, which fact may be indicated by designating them as already suggested, AB(ab) [A, a referring to the rough or smooth character of the coat and B, b to its color].

These primary hybrids, if bred *inter se,* will produce young of four different sorts, viz., rough pigmented, rough white, smooth pigmented and smooth white. A certain number of the animals of each sort will *breed true, i. e.,* will produce only their own sort when mated to animals like themselves. Theoretically there should be one *pure* individual of each of the four sorts in a total of sixteen young. The four pure individuals answer to the classes AB, Ab, aB, ab already mentioned.

But, besides these pure individuals, there will occur in three of the four classes *impure* or hybrid individuals, which will transmit to some of their young the dominant character or characters which they themselves possess, but to others of their young the corresponding recessive character or characters. Only the class of smooth white animals (of which there should be one in sixteen young) contains none but pure individuals, for they bear

* This is Mendel's use of lower-case letters to designate recessive characters, with which I have combined the use of a parenthesis when a character by nature recessive is not visible in the individual.

the two recessive characters (ab), and so conceal no hidden recessives. They may at once be set aside as pure. But in the other three classes nothing but actual breeding tests will serve to show which individuals are pure and which impure or hybrid. To each *pure* individual possessing one dominant and one recessive character there will be two others, *exactly like it in appearance*, but hybrid in one pair of characters. This statement applies to the two classes, rough-white and smooth-pigmented, in which the impure individuals would be designated A(a)b and aB(b) respectively. Such impure animals bred *inter se* would produce, in the case of rough-white parents, both rough-white and smooth-white offspring, and in the case of smooth-pigmented parents, both smooth-pigmented and smooth-white offspring.

In the class of rough-pigmented second-generation offspring, which combines the two dominant characters, there will be to each pure individual (AB) eight which are impure in one or both characters. Two of the eight will be hybrid in one character only, as in the rough *vs.* smooth character they form the class A(a)B; two other individuals will be hybrid in the other character, albino *vs.* pigmented, forming the class AB(b); while the remaining four will be hybrid in *both* characters, exactly like the entire first generation of offspring, AB(ab).

The task of the practical breeder who seeks to 'establish' or 'fix' a new variety, produced by cross-breeding, in a case involving two variable characters, is simply the isolation and propagation of that one in each sixteen of the second-generation offspring which will be *pure* as regards the desired combination of characters. Mendel's discovery by putting the breeder in possession of this information enables him to attack his problem systematically, with confidence in the outcome, whereas hitherto his work, important and fascinating as it is, has consisted largely of groping for a treasure in the dark.

The greater the number of separately variable characters involved in a cross, the greater will be the number of new combinations obtainable; the greater, too, will be the number of individuals which it will be necessary to raise in order to secure *all* the possible combinations; and the greater, again, will be the difficulty of isolating the pure, *i. e.*, stable forms from such as are similar to them in appearance but still hybrid in one or more characters. Mendel has generalized these statements substantially as follows: In cases of complete dominance, when the number of differences between the parents is n, the number of different classes into which the second generation of offspring fall will be 3^n, of which 2^n will be *pure* (stable); the remainder will be hybrid, though indistinguishable from pure individuals. The smallest number of individuals which in the second hybrid generation will allow of *one pure individual* to each visibly different class will be 4^n. (See Table IV.)

TABLE IV.

Number of Differences Between Parents.	Visibly Different Classes, Each Containing One Pure Individual.	Total Classes, Pure and Hybrid.	Smallest Number of Offspring Allowing One Individual to Each Class.	
n	2^n	3^n	4^n	
1	2	3	4	Tested by Mendel for peas and found correct.
2	4	9	16	
3	8	27	64	
4	16	81	256	Calculated.
5	32	243	1024	
6	64	729	4096	

The law of Mendel reduces to an exact science the art of breeding in the case most carefully studied by him, that of entire

dominance. It gives to the breeder a new conception of 'purity.' No animal or plant is 'pure' simply because it is descended from a long line of ancestors possessing a desired combination of characters; but *any* animal or plant is pure if it produces gametes of only one sort, even though its grandparents may among themselves have possessed *opposite* characters. The existence of purity can be established with certainty only by suitable breeding tests (especially by crossing with recessives), but it may be safely assumed for any animal or plant descended from parents which were like each other and had been shown by breeding tests to be pure.

Special Cases under the Law of Mendel.—It remains to speak of some special cases under the law of Mendel, which apparently are exceptions to one or another of the principles already stated, and which probably result from exceptional conditions known to us imperfectly. These special cases have come to light in part through Mendel's own work, in part through that of others.

1. *Mosaic Inheritance.*—It occasionally happens that in crosses which bring together a pair of characters commonly related as dominant and recessive, the two characters appear in the offspring in patches side by side, as in piebald animals and parti-colored flowers and fruits. The normal dominance apparently gives place in such cases to a balanced relationship between the alternative characters. What conditions give rise to such relationships is unknown, but when they are once secured they often prove to possess great stability, breeding true *inter se*. This, for example, is the case in spotted mice, which usually produce a large majority of spotted offspring. The balanced relationship of characters possessed by the parents is transmitted to the germ-cells, which are, not as in ordinary hybrid individuals D or R, but DR. This has been shown to be the case in spotted mice by Mr. Allen and myself, in a paper published elsewhere. (Castle and Allen, **:03**.)

2. *Stable Hybrid Forms.*—This is a case, in some respects similar to the last, which was familiar to Mendel (**:70**) himself. It sometimes happens, as we have seen, that the hybrid has a form of its own different from that of either parent. To such cases the law of dominance evidently does not apply. In a few cases—*Hieracium* hybrids (Mendel), *Salix* hybrids (Wichura) —it has been found that the hybrid form does not break up in the second generation and produce individuals like the grandparents, but breeds true to its own hybrid character. This can be explained only on one of two assumptions. Either the germ-cells bear the two characters in the balanced relationship, AB, as do those of spotted mice, or, of the two gametes which unite in fertilization, one invariably bears the character A, the other the character B. Of the two explanations, the former seems at present much the more probable.

3. *Coupled Characters.*—This is the phenomenon of correlation of characters in heredity. It is sometimes found that, in cross-breeding, two characters can not be separated. When one is inherited, the other is inherited also. Thus, in crossing different sorts of *Datura* (the Jamestown weed) it has been found that purple color of stem invariably goes with blue color of flowers, whereas green stems are constantly associated with white flowers. Again in mice, rabbits and most other mammals, white hair and pink eyes commonly occur together and may not be separated in heredity. Very rarely, however, as I have observed, an otherwise perfectly white guinea-pig has dark eyes; further the ordinary albino guinea-pig

with pink eyes has usually smutty (brown-pigmented) ears, nose and feet; and a race of mice with pink eyes, though partially pigmented coat, has formed the basis of some recent important experiments in heredity conducted by Darbishire (:02, :03) at Oxford, England. These exceptional conditions probably represent stable couplings of a *part only* of the dominant character (pigmented coat) with the recessive character (white coat), and are similar in kind to the DR character of spotted mice.

Further, coupling may occur between a number of characters greater than two, so that they form, to all intents and purposes, in heredity, one indissoluble compound character. Thus, Correns (:00) observed that in crosses between two species of stocks (*Mathiola incana* DC. and *M. glabra* DC.) the second generation hybrids showed reversion to one or the other of the parental forms in *all three of the principal differential characters* studied, viz., hairy or glabrous stems, violet or yellow-white flowers, and blue or yellow seed. A blue seed always produced a hoary plant bearing violet flowers; a yellow seed always produced a glabrous plant bearing yellow or white flowers.

4. *Disintegration of Characters.*—This is the converse of the foregoing process. Not only may characters apparently simple be coupled together in heredity to form composite units of a higher order, but characters which ordinarily behave as units may as a result of crossing undergo disintegration into elements separately transmissible. Thus the gray coat-color of the house-mouse is always transmitted as a dominant unit in primary crosses with its white variety; but in the second cross-bred generation a certain number of *black* mice appear, some or all of which are probably hybrids. For similar black mice obtained by crossing black-white with white mice have been shown, by breeding tests, to be hybrids, since on crossing with white mice they produce white mice, black mice, and, in one or two cases, gray mice also. Accordingly black mice clearly belong with grays in the category of dominant individuals [D or D (R)], but they have visibly *only the black constituent* of the gray coat, the remaining constituent, a rufous tint, having been separated from the black in consequence of cross-breeding. There is reason to believe that the rufous constituent may become recessive, *i. e.*, latent, either in the black individuals or in the reverted whites, or in both. It is seen separated from both the black and the white characters, in the chocolate-brown and reddish-yellow individuals obtained in cross-breeding.

A fancier of rabbits tells me that there occurs a similar disintegration of the composite coat-color of the 'Belgian hare,' when that animal is crossed with ordinary white rabbits, the result being the production of black, yellow and mottled individuals, in addition to ordinary gray-browns.

The various distinct colors or color patches of the guinea-pig have doubtless originated in a similar way—by resolution of the composite coat-color of the wild *Cavia,* upon crossing with an albino sport. This subject is now undergoing investigation.

Correns (:00) mentions a case in plants, which probably belongs in this same category. In crossing the blue-flowered (dominant) *Mathiola incana* with the yellowish-white-flowered (recessive) *M. glabra,* the second generation recessives produced in some cases pure white flowers, in others yellow flowers. In this case the recessive character, rather than the dominant, underwent disintegration.

5. *Departures from the Theoretical*

Ratios of Dominants to Recessives.—Considerable departures are to be expected when the number of offspring taken into consideration is small, but with increase in the number of offspring examined, the departures should grow less. This is usually found to be true. Mendel's numbers are shown by Weldon (:**02**) to be well within the limits of probable error. But certain cases have been observed in which departures of a particular sort persist even with considerable numbers of offspring. Thus Allen and I have found the recessive character, white, in mice to be inherited in about three per cent. more than the calculated number of cases, while the equally recessive dancing character is inherited in about thirty-three per cent. less than the calculated number of cases. These fairly uniform departures indicate, to my mind, a vitality, on the part of the recessive gamete, in one case somewhat superior, in the other much inferior, to that of the dominant gamete. Inferior vitality of gametes of either sort would result in greater mortality and so in a diminished number of individuals derived from such gametes.

Of course other explanations are possible, as, that the two sorts of gametes are *not* produced in equal numbers. More extended investigations of such cases can alone make their meaning clear.

6. *Reversal of Dominance.*—Exceptional cases are on record in which crossing of a dominant with a recessive has resulted in the production of *pure* dominants, or recessives, instead of hybrids. Such cases are, I believe, correctly referred by Bateson to the category of 'false hybridization' as described by Millardet, a phenomenon akin to parthenogenesis, in which sexual union has served merely to *stimulate one gamete to development* without bringing about its union with the other gamete.

It is possible, however, that there are cases in which one of a pair of characters is sometimes dominant, sometimes recessive. Tschermak (:**01**) believes that he has found a few such cases among cross-bred beans. Sex and certain other dimorphic conditions found in the higher animals and plants may prove to be cases of this sort.

Acceptance of Mendel's principles of heredity as correct must lead one to regard discontinuous (or sport) variation as of the highest importance in bringing about polymorphism of species and ultimately of the formation of new species.

A sport having once arisen affecting some one character of a species, may by crossing with the parent form be the cause of no end of disintegration on the part of any or all of the characters of the species, and the disintegrated characters may, indeed *must,* form a great variety of new combinations of characters, some of which will prove stable and self-perpetuating. Even if a particular combination of characters is uniformly eliminated by natural selection under one set of conditions, it may reappear again and again, and finally meet with conditions which insure its success.

We now have an explanation of the long-recognized principle that new types of organisms are extremely variable, whereas old types vary little. A new type which has arisen as a sport will cross with the parent form. The offspring will then inherit some characters dominant, others latent, and polymorphism of the race results. Only selection continued through long periods of time will serve to eliminate completely the latent recessives, and so to cause the disappearance of certain aberrant variations.

Bateson makes the pregnant suggestion that even cases of continuous variation may possibly prove conformable with Men-

delian principles. Take, for example, the height of peas. It has been found in certain crosses of a tall with a dwarf variety of pea, that the hybrid has an intermediate height. Now, if the hybrid produces pure germ-cells, dwarf and tall respectively, in equal numbers, the next generation will consist of three classes of individuals, dwarf, intermediate and tall, in the proportions 1 : 2 : 1. But if each of the original characters should undergo disintegration, we might get a dozen classes, instead of three, resulting in a practically continuous frequency-of-error curve.

SUMMARY.

1. The basic principle in Mendel's discoveries is that of the purity of the germ-cells; in accordance with this a cross-bred animal or plant produces germ-cells bearing *only one* of each pair of characters in which its parents differ. From it follows the occurrence in the second and later hybrid generations of a definite number of forms in definite numerical proportions.

2. Mendel's principle of dominance is realized in the heredity of a considerable number of characters among both animals and plants. In accordance with this principle, hybrid offspring have visibly the character of only one parent or the other, though they transmit those of both parents.

3. In other cases the hybrid has a distinctive character of its own. This may approximate more or less closely the character of one parent or the other, or it may be entirely different from both. Frequently the distinctive hybrid character resembles a lost ancestral character. In some cases of this sort, as in coat-color of mammals, the hybrid character probably results from a recombination of the characters seen in one or both parents, with certain other characters latent (that is, recessive) in one parent or the other.

4. There have been observed the following exceptions to the principle of dominance, or to the principle of purity of the germ-cells, or to both:

(*a*) Mosaic inheritance, in which a pair of characters ordinarily related as dominant and recessive occur in a balanced relationship, side by side in the hybrid individual and frequently in its germ-cells also. This balanced condition, once obtained, is usually stable under close breeding, but is readily disturbed by cross-breeding, giving place then to the normal dominance.

(*b*) Stable (self-perpetuating) hybrid forms result from certain crosses. These constitute an exception to both the law of dominance and to that of purity of the germ-cells. For the hybrid is like neither parent, but the characters of *both* parents exist in a stable union in the mature germ-cells produced by the hybrid.

(*c*) Coupling, *i. e.*, complete correlation may exist between two or more characters, so that they form a compound unit not separable in heredity, at least in certain crosses.

(*d*) Disintegration of characters apparently simple may take place in consequence of cross-breeding.

(*e*) Departures from the expected ratios of dominants to recessives may be explained in some cases as due to inferior vigor, and so greater mortality, on the part of dominants or recessives respectively.

(*f*) Cases of apparent reversal of dominance may arise from 'false hybridization' (induced parthenogenesis). Possibly in other cases the determination of dominance rests with circumstances as yet unknown.

5. Mendel's principles strengthen the view that species arise by discontinuous variation. They explain why new types are especially variable, how one variation

causes others, and why certain variations are so persistent in their occurrence.

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WILBUR CLINTON KNIGHT.

The subject of this sketch was born on a farm at Rochelle, Illinois, December 13, 1858. Early in his boyhood his parents, Mr. and Mrs. David A. Knight, removed to a farm at no great distance from Lincoln, Nebraska. Here he grew to young manhood, gaining the strength of body and mind which is so often developed in unfettered country life. Self-reliance and strength of character came to him in the struggle that he, in common with the other members of the family, had put forth in what was then the new west, in order to wrest from nature the daily bread. Life in all of its forms, and the hills and rocks appealed strongly to him. By the time that he had secured such education as the country school afforded he had also become more than ordinarily familiar with the fauna, the flora and the geological formations of his neighborhood.

Being unusually fond of athletic sports, of fishing and of hunting, he led many a merry party in these pursuits, frequently to the complete exhaustion of most of his fellows. In more recent years, his many friends who at one time or another shared

camp life with him in the Rocky Mountains remember not only his skill with rod and gun but more particularly their dismay as they tried to follow those long swinging strides that carried him over mountain and plain. The restless energy of the naturalist-explorer was his, and day after day he urged himself from locality to locality in search of new finds. Even when loaded down (as he usually was) with collecting implements, specimen bag and camera he seemed never to tire.

As early as his means would allow, he entered the University of Nebraska, from which he graduated in 1886, receiving the degree B.Sc. As a student there he early demonstrated his scientific tendencies. The biological sciences and especially geology were his delight. Under the inspiration which Dr. Bessey always exercises upon his students, Mr. Knight seriously contemplated taking up botany as his life work, and while his inclination to study the rocks and the story that they reveal proved stronger, he never lost his interest in the flora of the great plains and the mountains where his life was spent.

He was at various times a graduate student at the University of Nebraska, his alma mater, from which he received the degree of M.A. in 1893 and the doctorate in philosophy, in 1901. He had also studied for a short time at the University of Chicago.

After all has been said about his work in the schools, those who knew him best understand that his degrees represent not what he carried *away* from the class-room and laboratory, but rather what he carried *to* these as he came fresh from the fields that he had explored. When he presented himself before academic faculties for examination the funds of knowledge that interested those faculties were not facts that he had gleaned from books but those that he had at first hand. He read widely and assimilated much, but he accepted little on mere 'authority.' True scientist that he was, he accepted statements cautiously, unless the facts upon which they were founded were apparent. If his own experience confirmed or if he were able to verify, he accepted all truth with joy. In the field he was a keen observer and he soon accumulated a store of facts upon which he based his hypotheses and later his more mature judgments. When he had reached a conclusion, he modestly yet firmly held to that conclusion unless it could be shown that he was in error about the underlying facts.

He had a wide acquaintance among scientific men, many of whom he had personally met. The great expedition to the fossil fields of Wyoming, in 1899, which he so successfully conducted, brought him into contact with scores of men who recall those weeks as a time of profit and delight and Professor Knight as a cherished personal friend.

Dr. Knight was great not merely from a scholastic point of view, but quite as much from the grasp he had upon economic questions. He was actively in touch with the industrial problems of his state, and his opinions were eagerly sought by corporate as well as private interests. This drew him into many and diverse fields, as the appended partial list of his publications will show.

To the University of Wyoming he had made himself indispensable. Elected to the chair of geology and mining engineering in 1893, he continued in that position, with the added duties of principal of the school of mines, until his death. Faculty and students alike recognized in him a successful teacher, a wise counselor and a true friend.

The other positions that he held at various times may only be mentioned: Assistant territorial geologist, 1886–7; as-

sayer at Cheyenne, 1887–8; superintendent of mines, Colorado and Wyoming, 1888–93; state geologist, 1898–9; for many years consulting expert to the Union Pacific Railroad Company upon mineral and oil lands and upon artesian basins; at the time of his death, on leave from the university, consulting expert for the Belgo-American Oil Company.

Among the honors that had come to him, membership in the following learned societies should be noted: Fellow of the Geological Society of America, member of the American Institute of Mining Engineers, member of the National Geographical Society.

Of his home relations it may be said that they illustrated the best in American domestic and social life. His parents survive him and are justly proud of the work that he had accomplished—for in his brief forty-four years he had more to his credit than most of the scientific men who are permitted to round out their three score years and ten.

He was married in 1889 to E. Emma Howell, a delightful and talented young woman whom he had known during his college career. The union proved a most happy one and the four promising children (one daughter and three sons) are the joy of the loving wife that mourns the loss of a tender and devoted husband.

The home of Mr. and Mrs. Knight was always open to their friends, and they took great pleasure in providing social occasions that should serve other purposes than merely that of killing time.

In the passing away of Professor Knight, on July 28, 1903, after a few days' illness from peritonitis, the family lost its hero, the community a choice citizen, the university an honored member, the state an important agent in its industrial development, the scientific world one who, having done much, was just on the threshold of greater things, and the church a member who lived the religion that he professed.

Aven Nelson.

University of Wyoming,
Laramie, Wyo.

A LIST OF PAPERS PUBLISHED BY WILBUR C. KNIGHT.

Bulletin No. 14, Wyoming Experiment Station, University of Wyoming; 'Geology of the Wyoming Experiment Farms, and Notes on the Mineral Resources of the State,' October, 1893.

'The Coal Mines of Wyoming,' *Mineral Industry*, 1894.

'Coal and Coal Measures of Wyoming,' 16th Annual Report, U. S. G. S., Part IV., 1894.

'A New Jurassic Plesiosaur from Wyoming,' Science, October 4, 1895.

'The Mining Industry of Wyoming,' *Mining Industry* (Denver), June, 1896.

Bulletin No. I., Petroleum Series, School of Mines University of Wyoming; 'The Petroleum of the Salt Creek Oil Field, its Technology and Geology,' June, 1896.

'The Salt Creek Oil Field,' *Engineering and Mining Journal*, January, 1896.

'The Petroleum Fields of Wyoming,' *Mineral Industry*, 1896.

'The Petroleum Industry of Wyoming,' *American Manufacturer and Iron World*, May 29, 1896.

Bulletin No. II., Petroleum Series, School of Mines, University of Wyoming; 'The Petroleum Oil Fields of the Shoshone Anticlinal, Geology of the Popo Agie, Lander and Shoshone Oil Fields,' January, 1897.

'The Wyoming Natural Soda Deposits,' *Mineral Industry*, 1897.

'The Origin of the Soda Deposits of Wyoming,' *Mining Industry* (Denver), November, 1898.

'Prehistoric Quartzite Quarries of Eastern Central Wyoming,' Science, March 4, 1898.

'Some New Jurassic Vertebrates from Wyoming,' *American Journal of Science*, Vol. V., 1898. First and second papers.

'Description of Bentonite, a new variety of Clay,' *Engineering and Mining Journal*, LXIII. and LXVI.

Bulletin No. III., Petroleum Series, School of Mines, University of Wyoming; 'The Geology of the Oil Fields of Crook and Uinta Counties,' November, 1899.

'Some New Data for Converting Geological Time into Years,' Science, October 4, 1899.

'The Permian of Nebraska,' *Journal of Geology*, May–June, 1899.

'Jurassic Rocks of Southeastern Wyoming,' Bulletin of the Geological Society of America, Vol. XI., 1900.

'The Present Outlook of the Coal Industry in Wyoming,' *Wyoming Industrial Journal*, June, 1900.

'Some New Jurassic Vertebrates from Wyoming,' Third Paper, *American Journal of Science*, August, 1900.

Bulletin No. 45, Wyoming Experiment Station, University of Wyoming; 'A Preliminary Report of the Artesian Basins of Wyoming, June, 1900.'

'The Fossil Field Expedition of 1899,' *National Geographical Magazine*, December, 1900.

'Potassium Nitrate in Wyoming,' SCIENCE, January 25, 1901.

'Geology of Bates's Hole,' *Bulletin Geological Society of America*, Vol. XII., 1901.

Special Bulletin, School of Mines, University of Wyoming; 'The Swetwater Mining District.'

Bulletin No. IV., Petroleum Series, School of Mines, University of Wyoming, 'Geology of the Oil Fields of the Natrona Country, excepting Salt Creek.'

'The Laramie Plains Red Beds and Their Age,' *Journal of Geology*, Vol. X., No. 4, 1902.

Bulletin No. 49, Wyoming Experiment Station, University of Wyoming; 'Alkali Lakes and Deposits (Alkali Series IV.).' Experiment Station.

'The Coal Fields of Southern Uinta County,' *Bulletin of the Geological Society of America*, Vol. XIII.

'The Petroleum Industry of Wyoming,' 22d Annual Report of the Director of the Geological Survey.

'Wyoming Copper Development,' *Mineral Industry*, 1901.

'Wyoming Gold Outlook,' *Mineral Industry*, 1902.

Bulletin No. V., Petroleum Series, School of Mines, University of Wyoming; 'The Newcastle Oil Field.'

'Discovery of Platinum in Wyoming,' *Engineering and Mining Journal*, LXII., 845.

'Petroleum Fields of Wyoming,' *Engineering and Mining Journal*, LXII., 358 and 628.

'Wyoming Oil,' *Petroleum Review*, London.

'Rare Metals in the Ore from The Rambler Mine, Wyoming,' *Engineering and Mining Journal*, LXIII., No. 2.

'Epsom Salts Deposits of Wyoming,' *Engineering and Mining Journal*, February 14, 1903.

'Petroleum Fields of Wyoming,' *Engineering and Mining Journal*, May 24, 1902.

'Mining in Wyoming in 1902,' *Engineering and Mining Journal*, January 3, 1903.

Bulletin No. 55, Wyoming Experiment Station, University of Wyoming; 'The Birds of Wyoming.'

'The Geology of the Leucite Hills of Wyoming.' (In collaboration with Dr. J. F. Kemp.) *Bulletin of the Geological Society of America*, 1903.

'Fossil Elephants in Wyoming,' SCIENCE, 1903.

'Notes on *Baptanadon marshi*, n. s.,' *American Journal of Science*, July, 1903.

Bulletin No. VI., Petroleum Series, School of Mines, University of Wyoming; 'The Bonanza, Cottonwood and Douglas Oil Fields,' July, 1903.

SCIENTIFIC BOOKS.

Lehrbuch der vergleichenden Histologie der Tiere. Von Dr. KARL CAMILLO SCHNEIDER, Privatdozent an der Univ. Wien, mit 691 Abbildungen im Text. Jena, Verlag von Gustav Fischer. 1902.

This comparative histology is another instance of the astonishingly brief time in which, in Vienna, a great work may be brought to completion. The heavy volume of 939 pages contains also a bibliography of 36 pages and an index.

The work is divided into a general and a special part. The plan has been to bring together in the general part the weightiest results for comparison by a presentation of the leading points of view, while in the special part leading groups are treated by taking up typical representatives in detail.

This plan has not been carried out completely, however. A number of groups, especially the Tunicata, and still further the Trematoda, Acanthocephala, Rotatoria, Siphunculoidea, Cephalopoda, Myriapoda, Arachnoidea, Scyphomedusa, Ophiuroidea, Echinoidea, Bryozoa, Brachiopoda, typical fishes, reptiles and birds, have not been considered at all or only superficially. Even the remaining types have not been worked up with the completeness one might wish. Still the work is a remarkable and valuable one. The text, to a considerable extent, is based on the researches of the author, while the literature, to which extensive reference is made, has served chiefly as control. Wherever the author has been dependent on literature

alone for his view, credit is given and the literature cited.

In the general part, the incompleteness of the chapter on 'Organology' is noticeable. While in many respects the material has not been sufficiently worked up, in other respects it has been carried beyond the borders of comparative histology. In the general part, the chapter on 'Architectonics,' the different planes of organization of the Metazoa have been discussed, and at the close of the chapter a system (page 238) has been devised which is the key to the systematic arrangement of the special part.

Histology, in this book, is not considered entirely in the sense of microscopic anatomy, but primarily as morphological cytology. Tissues are associations of cells of the same sort. In discussing tissues the author concerns himself first with their structural characteristics, but secondly, also with their relation to the composition of the entire organism.

The dividing of the Metazoa into two principal groups, the Pleromata and the Cœlenterata, is based, for a great part, on histologic grounds.

It is very evident the author has worked with a plan or outline in hand which has enabled him to produce a well-written, usable book. Of the 691 illustrations many are excellent, while only a few give one the feeling that the work was done under pressure. As a work of reference the book is very valuable, for it embodies not only much that is original, but the results of hundreds of investigators have been worked over and embodied in the text. As a text-book it is, of course, entirely too bulky to be considered. Still when one considers the remarkable activity in Germany in the field of microscopic anatomy as illustrated in Oppel's 'Vergleichende Mikroskopische Anatomie der Wirbeltiere,' three large volumes with a total of 2,400 pages in which the author has but completed his consideration of the alimentary tract, one is led to feel that in another decade Schneider's work may be a primer.

Burton D. Myers.

Indiana University,
Bloomington, Indiana.

SOCIETIES AND ACADEMIES.

AMERICAN MATHEMATICAL SOCIETY.

The tenth summer meeting and fourth colloquium of the American Mathematical Society were held at the Massachusetts Institute of Technology during the week August 31 to September 6, 1903. Forty-seven members of the society attended the sessions of the regular meeting, which occupied the first two days of the week. The colloquium opened on Wednesday morning, with a total attendance of thirty-one. Three courses of lectures were given, as follows: Professor E. B. Van Vleck, of Wesleyan University, six lectures on 'Selected Topics in the Theory of Divergent Series and of Continued Fractions'; Professor H. S. White, of Northwestern University, three lectures on 'Linear Systems of Curves on Algebraic Surfaces'; Professor F. S. Woods, of the Massachusetts Institute of Technology, three lectures on 'The Connectivity of Non-Euclidean Space.'

The following persons were elected to membership in the society: Professor D. P. Bartlett, Massachusetts Institute of Technology; Professor C. E. Comstock, Bradley Polytechnic Institute, Peoria, Ill.; Mr. H. N. Davis, Harvard University; Mr. W. J. Graham, New York, N. Y.; Mr. N. J. Lennes, Chicago, Ill.; Mr. T. J. McCormack, La Salle, Ill.; Dr. L. I. Neikirk, University of Pennsylvania; Dr. A. B. Pierce, University of Michigan; Professor W. J. Rush, Iowa College; Miss M. E. Trueblood, Mt. Holyoke College; Mr. C. B. Upton, Columbia University; Dr. Oswald Veblen, University of Chicago; Mr. R. H. Williams, Columbia University. Seventeen applications for membership were received.

The committee on definitions of college entrance requirements in mathematics, appointed at the summer meeting of 1902, presented a report, which was received and recommended for publication. The report will appear in the *Educational Review* and in the *Bulletin* of the society. A committee was appointed to prepare for the October meeting a list of nominations of officers and members of the Council for the year 1904.

The following papers were read at this meeting.

I. J. Schwatt: 'On the length of curves.'

T. J. I'A. Bromwich: 'Similar conics through three points.'

D. R. Curtiss: 'Binary families in a triply connected region, with especial reference to hypergeometric families.'

John Eiesland: 'On a certain system of conjugate lines on a surface transformable into asymptotic lines by means of Euler's transformation.'

Edward Kasner: 'A class of conformal transformations.'

Edward Kasner: 'Notes in the theory of surfaces.'

E. R. Hedrick: 'Note on the existence of a continuous first derivative.'

G. A. Bliss: 'Jacobi's condition in the calculus of variations when both end points are variable.'

Arnold Emch: 'Note on the p-discriminant of ordinary differential equations of the first order.'

Helen A. Merrill: 'On a notable class of linear differential equations of the second order.'

Florian Cajori: 'On the circle of convergence of the powers of a power series' (preliminary communication).

E. T. Whittaker: 'An expression of certain known functions as generalized hypergeometric functions.'

W. H. Young: 'On a test for non-uniform convergence.'

J. I. Hutchinson: 'On the automorphic functions of signature (0, 3; 2, 6, 6).'

B. O. Peirce: 'On the lines of certain classes of solenoidal or lamellar vectors symmetric with respect to an axis.'

H. T. Eddy: 'The multiplication of complex numbers and of vectors compared.'

J. N. Van der Vries: 'On monoids.'

Jacob Westlund: 'On the congruence $x^{\phi(P)} \equiv 1$ mod. P^n.'

Alfred Loewy: 'Zur Gruppentheorie mit Anwendungen auf die Theorie der linearen homogenen Differentialgleichungen.'

Saul Epsteen: 'Semireducible hypercomplex number systems.'

L. E. Dickson: 'On the subgroups of order a power of p in the quaternary abelian group in the Galois field of order p^n.'

L. E. Dickson: 'The subgroups of order a power of 2 of the simple quinary orthogonal group in the Galois field of order $p_n = 8l \pm 3$.'

L. E. Dickson: 'Determination of all groups of binary linear substitutions with integral coefficients taken modulo 3 and of determinant unity.'

L. E. Dickson: 'Determination of all the subgroups of the known simple group of order 25920.'

L. E. Dickson: 'The systems of subgroups of the quaternary abelian group in a general Galois field.'

C. N. Haskins: 'On the invariants of quadratic differential forms.'

Frank Morley: 'On projective coordinates.'

Frank Morley: 'On a skew quadrangle covariant with six points of space' (preliminary communication).

E. B. Wilson: 'The projective definition of area.'

R. S. Woodward: 'On the values of the stretches and the slides in the theory of strain.'

R. S. Woodward: 'The radial compressibility of the earth compatible with the Laplacian law of density distribution.'

E. O. Lovett: 'Periodic solutions of the problem of four bodies.'

E. O. Lovett: 'Central conservative systems with prescribed trajectories.'

S. E. Slocum: 'Rational formulas for the strength of concrete-steel beams.'

A. S. Chessin: 'On a class of linear differential equations.'

C. M. Mason: 'On certain systems of differential equations: generalization of Green's functions, analytic character of the solutions.'

E. V. Huntington: 'A set of independent postulates for the algebra of logic.'

Pleasant social features of the meeting were the reception tendered to the society by Professor and Mrs. Pickering, at the Harvard College Observatory, where the rich collection of stellar photographs was visited under Professor Pickering's guidance; several informal and well-attended dinners and evening gatherings; and on Thursday afternoon an excursion to Nantasket in Boston harbor.

The next meeting of the society will be held at Columbia University, on Saturday, October 31.

F. N. Cole,
Secretary.

DISCUSSION AND CORRESPONDENCE.

TOXIC EFFECT OF ACIDS ON SEEDLINGS.

In a recent number of Science (Vol. XVIII., p. 453, September 4, 1903) there is a communication describing the effect of solutions of certain bases and acids upon seedlings

of Indian corn. This paper is remarkable in that no mention is made of the previous work of Heald* upon this plant, although the work of Kahlenberg and True, suggesting Heald's work, and published at the same time, in the same journal,† is freely quoted. This omission is the more remarkable since the author's results, when working with acids, are widely different from those obtained by Heald. The undersigned, in collaboration with Mr. J. F. Breazeale, had occasion last winter to repeat the work of Heald, working to closer limits than that investigator had found desirable. It may be worth while to state the results of these three investigations as to the limit of dilution for various acids with seedlings of corn.

	Loew.	Heald.	Cameron and Breazeale.
Hydrochloric acid..	n/512	n/3,200	n/3,000.
Sulphuric acid.....	n/512	n/3,200	n/3,000.
Nitric acid........		n/3,200	n/2,250.
Hydrobromic acid..		n/3,200	
Acetic acid.........		n/400 ‡	n/850.
Malic acid.........			n/1,250.
Oxalic acid........			n/1,750.
Succinic acid.......			n/600.

Just what is meant by 'toxic limit' seems to be somewhat indefinite judging from the printed descriptions of the work of this kind, but in the three investigations under consideration the same methods of work and the same, or very similar, criteria have been used, and the comparison seems to be fair. The confirmation of the results of Heald by those obtained in my own laboratory makes those of Loew the more inexplicable.

The author expresses astonishment that the limits for maize should vary so widely from that found for *Lupinus albus* by Kahlenberg and True. The work in my own laboratory, as well as that of Heald, has shown that very much greater differences exist when other plants are involved, and that *a priori* predications upon this point are at present impossible.

* *Bot. Gazette,* 22, 125 (1896).

† *Bot. Gazette*, 22, 81 (1896).

‡ So stated in Heald's tabulation, but from the description of his experiments it seems probable that this is a typographical slip, and should be n/800.

He also seems to have difficulty in understanding the relative action of kations in the presence of more toxic anions. The literature of this subject is now fairly large, as witness the work of Loeb in Chicago, Coupin in France, not to mention a number of other investigators, and this particular point has been specifically discussed in connection with agricultural plants by Kearney and myself,* and more recently by True and Gies,† although no reference is made to any of these investigations in the paper under discussion. It may be well to state here that the work done in my laboratory, which I have already communicated to the American Chemical Society at its meeting in Cleveland, Ohio, June 30, 1903, will be described shortly from a technical point of view in the *Journal of Physical Chemistry,* and its value for and bearing upon certain important agricultural questions will be fully discussed in an early publication from the Department of Agriculture.

F. K. Cameron.

U. S. Dept. of Agriculture, Bureau of Soils, Washington, D. C., September 7, 1903.

* Report 71, U. S. Dept. of Agriculture (1902)

† *Torrey Botanical Club*, 30, 390 (1903).

SHORTER ARTICLES.

PRIMITIVE FLAGEOLETS.

There is a kind of primitive flageolet made by the western tribes of North American Indians as follows: A section of cane is open at both ends, but has a joint between the ends; the septum of this joint closes the tube. Two holes from three sixteenths to one fourth of an inch in diameter are made from the outside into the cavity, close to and on opposite sides of the septum. A shallow air channel is cut in the outside of the cane from one hole to the other, and three, four or six finger holes are made in the cane in the part below the septum. The Rees and Shoshones make a septum of wax. When so constructed and nothing further added the 'mystery flute,' described by early writers, is completed when the upper of the two holes at the septum and the air channel are covered by a finger. Blowing through the cane from the upper end produces a sound whose pitch is changed by the finger holes.

The mystery consists in placing the finger over the upper hole and air channel exactly in the correct place. Usually a piece of cloth, skin, etc., is tied around the cane at this point.

The National Museum has specimens of this instrument from the following tribes, viz., Apaches, Cocopas, Mohaves, Papagos, Pimas, Rees and Shoshones. Other examples have a tube with septum made by splitting a cylinder, excavating the halves and gluing them together.

I had supposed until recently that this method of constructing the flageolet was not to be found outside of North America. I have never read a description of this instrument except from travelers in North America. But recently in a collection of specimens made by Dr. W. L. Abbott, at Siaba Bay, Island of Nias, off the west coast of Sumatra, I find a specimen made in the manner stated above except that in the place of a septum the bore of the cane is plugged with wax. The covering of the upper hole and air channel is a long leaf wrapped around and protected by a bandage of cotton sheeting.

It has seven finger holes and a thumb hole. Its Malay name is Siro'oni.

E. H. Hawley.

SCIENTIFIC AND TECHNICAL EXAMINATIONS.

The United States Civil Service Commission invites special attention to the examinations which will be held, beginning October 21, 1903, at various places throughout the United States, for the following-named positions:

Acting assistant-surgeon, Public Health and Marine Hospital Service.

Aid, Coast and Geodetic Survey.

Assistant examiner, Patent Office.

Assistant (scientific), Department of Agriculture.

Bookkeeper, Departmental Service.

Civil and electrical engineer, Departmental Service.

Civil and electrical engineer, Philippine Service.

Civil engineer and draftsman.

Computer:

- Coast and Geodetic Survey.
- Nautical Almanac Office.
- Naval Observatory.

Deck officer, Coast and Geodetic Survey.

Draftsman:

- Architectural.
- Copyist, topographic.
- Junior architectural.
- Topographic, Land Office Service.

Electrical engineer and draftsman.

Engineering and hydrographic aid.

Farmer—industrial teacher.

Farmer—industrial teacher with a knowledge of irrigation.

Fish culturist.

Irrigation engineer.

Kindergarten teacher.

Manual training teacher.

Matron — seamstress — female industrial teacher.

Meat inspector.

Mechanical and electrical engineer.

Observer.

Pharmacist, Public Health and Marine-Hospital Service.

Physician, Indian Service.

Superintendent of construction.

Teacher, Indian Service.

Trained nurse, Indian Service.

Trained nurse, Philippine Service.

As the demand for persons with these qualifications is greater than the present supply, the Commission invites all persons who are qualified to take these examinations, as they offer an excellent opportunity to enter the Federal service, with good prospect for advancement. Information concerning the character of these examinations, the required qualification, age limits, salaries at which appointments are made, etc., may be found in the Manual of Examinations revised to July 1, 1903.

SCIENTIFIC NOTES AND NEWS.

Dr. H. W. Wiley, chief of the Bureau of Chemistry, U. S. Department of Agriculture, has returned from Europe, where he has been studying the question of enforcing the law in regard to the exclusion of adulterated and falsely labeled food.

Professor H. S. Graves has returned from Europe where he has been making a study of the schools of forestry in Germany and Austria.

Dr. C. E. Beecher, professor of historical geology at Yale University, has during the summer been carrying on paleontological work in Canada, especially in the Lake St. John region of Quebec.

President Harper, of the University of Chicago, has returned to the United States. He has spent most of the summer in Turkey making arrangements for the proposed Babylonian explorations.

The Vienna Academy of Sciences has appointed a committee to study pitchblende, the substance from which radium is derived. Baron Auer von Welsbach, has placed his laboratories at the disposal of the committee.

Several members of the commission on London traffic, including Sir David Barbour and Baron Ribblesdale, have sailed for the United States to inquire into the street railway systems of New York and Boston.

The Emperor of Germany has conferred the title of *Wirklicher Geheimer Rath,* on Professor E. von Behring, the eminent pathologist.

Professor Frederick C. Clarke, head of the Department of Economics and Sociology of the Ohio State University, committed suicide on September 19.

Dr. Frank A. Hill, secretary of the Massachusetts State Board of Education, a trustee of the Massachusetts Institute of Technology, of the State Agricultural College at Albany and of the Boston Museum of Fine Arts, died on September 12, at the age of sixty-two years.

Professor Alexander Bain, for many years professor of logic in the University of Aberdeen, died on September 17, at the age of eighty-five years. Dr. Bain was the author of an important series of books on psychology, logic and English. His works on 'The Senses and the Intellect,' in 1855, and 'The Emotions and the Will,' in 1859, in many ways laid the foundations of modern scientific psychology.

The directors of the Dallas Commercial Club have called a national convention to be held in Dallas on October 8, to consider the boll weevil situation in the cotton growing districts. The attendance of delegates from all the cotton states and of representatives of the national Department of Agriculture is desired.

A press despatch from Berlin states that the imperial budget for 1904, now in preparation, allots $37,500 for combating typhus, which is specially virulent in Bavaria, Prussia and Alsace-Lorraine. The contamination of the rivers appears to be frequently the cause of the fever.

We learn from *Nature* that shortly before his death, the late Professor Nocard, of Paris, strongly urged the authorities of the Liverpool School of Tropical Medicine to make the institution available for the instruction of veterinary surgeons. A committee has now been formed for the purpose of giving effect to this suggestion, and the veterinary branch is open for the reception and instruction of students. It is under the direction of Professors Boyce and Sherrington, with adequate assistance, and a farm has been provided at Runcorn for its requirements.

The Electrical World and Engineer states that M. H. Duportal, the French inspector-général des Ponts et Chaussée, has selected St. Gervais as the starting point for the railway which, it is hoped, in a few years, will reach the summit of Mont Blanc. The project is identified with the name of M. Vallot, the director of the Mont Blanc Observatory, and is for a railway starting from Les Houches. The idea seems to be to get the shortest possible and most sheltered line, enabling the summit to be reached in all seasons; and it is conceded that M. Vallot's survey is the best possible for the purpose. M. Duportal's scheme does not supersede its predecessor, however; rather it will prepare the way for it; and it has the great merit of serving the immediate and practical necessities of the district. The first section of the proposed electric line reaches the Aiguille de Gouter almost direct from Fayet by way of the Bion-

nassay Valley, which faces full south, and consequently is always free from snow early in the year, at any rate as far as the Tête Rousse. An open-air line by this route is, therefore, feasible; and this is important, as tourists naturally desire to see the perspectives of the mountains, which would be impossible if the line should be tunneled all the way.

THE annual report for 1902 on the ice-conditions in the arctic seas has been issued by the Danish Meteorological Institute. According to the abstract in the *Geographical Journal*, information has come to hand in somewhat fuller measure than in the previous year. After a review of the state of the ice in the different seas around the polar area, the following general conclusions are arrived at. In 1902 the winter ice broke up very late, and the polar ice lay considerably nearer the northern coasts of Asia and Europe than in a normal year. The East Greenland current carried an abnormal quantity of pack-ice, though on the other hand an unusually small number of icebergs were carried from Greenland to the temperate seas, while the extent of polar ice in the northern branches of Baffin bay was smaller than in other recent years. The summer was rough and unsettled in all arctic and subarctic regions (with the partial exception of West Greenland), northerly and easterly winds predominating in the seas north of the Atlantic. These facts quite bear out the conclusions drawn from a consideration of the state of the ice in 1901, viz., that the accumulation of ice north of Spitzbergen caused by the prevailing westerly winds of that year would have an unfavorable influence on the state of the ice round Iceland and Greenland in 1902. Alike in the Barents sea, the region of Franz Josef Land, and around Spitzbergen, East Greenland, and Iceland the conditions were very unfavorable. The northeast, east, and southeast coasts of Spitzbergen were quite inaccessible through the summer; the pack-ice lay in a close broad belt off the coast of East Greenland, rendering access to the northern parts of the coast exceedingly difficult; while round Iceland the state of the ice was more unfavorable than ever since 1892.

UNIVERSITY AND EDUCATIONAL NEWS.

A GIFT of another $300,000 dormitory to the Sheffield Scientific School of Yale University by Mr. F. W. Vanderbilt, Yale, '76, of New York, is announced. About a year ago Mr. Vanderbilt gave a dormitory to the Sheffield Scientific School in memory of the late Cornelius Vanderbilt.

THE California Methodist Episcopal Conference has completed the work of raising an endowment fund of $100,000 for the University of the Pacific.

BY the gift of a daughter of the late Charles Pratt of Brooklyn, the Department of Physical Education of Amherst College is to receive an additional annual income of $1,500. Under the conditions of the gift, a graduate of the college may by a year or more of work in the theory and practise of physical education fit himself to become a teacher of that science, while assisting in the work of the department.

AFTER many delays the Pittsburg city councils have authorized the mayor to accept on behalf of the city the Flynn-Magee site purchased for the location of the Carnegie Technological School. The site includes thirty-two acres on the eastern border of Schenley Park.

WILLIAMS HALL, the new building to be devoted to the departments of geology and mechanical engineering at Lehigh University, will be formally opened on October 8, in connection with the twenty-fourth annual celebration of Founder's Day. Addresses will be delivered by Professor Edward H. Williams, Jr., of the department of geology and mining, who is the principal donor of the building, and by Dr. Rossiter W. Raymond, secretary of the American Institute of Mining Engineers.

BRIEFS have been filed opposing the application of the trustees of Rutgers College for the payment of $80,000 allowed by the last New Jersey legislature in settlement of the claim of the college for back scholarships.

THERE has been incorporated in Quebec a school for the purpose of establishing and carrying on an agricultural school, and experimental farms. This school is to maintain

two or more schools and experimental farms in the Province of Quebec, one to be located in the district of Montreal and one in the district of Quebec. Each of the two schools is to contain accommodations for at least 50 pupils, who will be given a full course of three years' tuition, together with board, free of charge.

The Council for the Extension of Higher Education in North Staffordshire has approved plans for the proposed new college, including departments of instruction in mining and metallurgy, pottery, chemistry, and physics, and for administrative buildings, at an estimated cost of about $100,000.

Announcement is made that the first twelve students under the Rhodes scholarship will enter Oxford in October. Seven of the twelve will be from South Africa and five from Germany. They will be distributed in various colleges. It is stated that the conditions made by Mr. Rhodes in his will have been satisfactorily carried out and the men have been chosen, not only for their intellectual attainments, but for the qualities of character which Mr. Rhodes regarded as typical of the best manhood. The Americans and the remainder of the colonial scholars will not arrive at Oxford until 1904.

As we have already noted Dr. John H. Finley will be installed as president of the College of the City of New York on the morning of September 29, and the corner stone of the new building will be laid in the afternoon of the same day. The president will make an inaugural address, among others there will be addresses by Governor Odell, Mayor Low, Ex-president Cleveland and Presidents Butler of Columbia, Schurman of Cornell, Hadley of Yale and Remsen of Johns Hopkins.

Dr. N. M. Harris, of the Johns Hopkins Medical School, has accepted a position in the Bacteriological Laboratory of the University of Chicago.

Cornell University Medical College has provided for a chair of experimental pathology and bacteriology to carry on research work, at the Loomis Laboratory. Dr. Bertram H. Buxton is to be in charge, and will be assisted by Dr. Victor C. Vaughan, Jr.

Dr. Peter Potter, acting head of the department of anatomy in the University of Missouri, has accepted an associate professorship of anatomy in the Medical Department of St. Louis University.

The position in the Horticultural Department of Amherst Agricultural College, vacant by the resignation of Dr. G. A. Drew, has been filled by the appointment of Professor George O. Green of the Kansas Agricultural College.

At Williams College, Mr. Elmer I. Shepard, A.B. (Williams, 1900), has been appointed instructor of mathematics, and Mr. Brainerd Mears, A.B. (Williams, 1903), assistant in chemistry.

Appointments in the Chemical Department of the North Carolina College of Agriculture and Mechanic Arts, for the year 1903–4 have been made as follows: Wm. G. Morrison, M.A. (Virginia), instructor in chemistry; Robt. W. Page, B.S. (Columbia), instructor of analytic chemistry and metallurgy; Albert A. Haskell, B.S. (Massachusetts Institute of Technology), instructor in dyeing; O. M. Gardner, B.S. (North Carolina College of Agricultural and Mechanic Arts), instructor in chemistry.

The chair of physics and electrical engineering, at the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y., has been filled by the appointment of Byron Briggs Brackett, A.B., A.M. (Syracuse), Ph.D. (Johns Hopkins).

Mr. John McFarlane, M.A. (Edinburgh and Cambridge), has been appointed lecturer in political and commercial geography in the Owens College, Manchester.

Dr. J. Tafel has been promoted to the professorship of chemistry and directorship of the laboratory at Würzburg, and Dr. W. Manchot, now docent at Göttingen, has been called to the associate professorship at Würzburg.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 2, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

II.

HOW TO GET MORE UNIVERSITIES.

What, then, is to be done? Fortunately, we have a precedent admirably in point, the consideration of which may help us to answer this question.

I have pointed out that in old days our Navy was chiefly provided by local and private effort. Fortunately for us, those days have passed away; but some twenty years ago, in spite of a large expenditure, it began to be felt by those who knew that in consequence of the increase of foreign navies, our sea-power was threatened, as now, in consequence of the increase of foreign universities, our brain-power is threatened.

The nation slowly woke up to find that its enormous commerce was no longer insured at sea, that in relation to foreign navies our own had been suffered to dwindle to such an extent that it was no longer capable of doing the duty which the nation expected of it even in time of peace. At first, this revelation was received with a shrug of incredulity, and the peace-at-any-price party denied that anything was needed; but a great teacher arose; * as the

* Captain Mahan, of the U. S. Navy, whose book, 'On the Influence of Sea-power on History,' has suggested the title of my address.

facts were inquired into the suspicion changed into an alarm; men of all parties saw that something must be done. Later, the nation was thoroughly aroused, and with universal agreement the principle was laid down that, cost what it might to enforce our sea-power, our Navy must be made and maintained of a strength greater than those of any two possibly contending powers. After establishing this principle, the next thing to do was to give effect to it. What did the nation do after full discussion and inquiry? A bill was brought in in 1888, and a sum of 21,500,000*l.* was voted in order, during the next five years, to inaugurate a large ship-building program, so that Britain and Britain's commerce might be guarded on the high seas in any event.

Since then we have spent 120,000,000*l.* on new ships, and this year we spend still more millions on still more new ships. If these prove insufficient to safeguard our sea-power, there is no doubt that the nation will increase them, and I have not heard that anybody has suggested an appeal to private effort.

How, then, do we stand with regard to universities, recognizing them as the chief producers of brain-power and therefore the equivalents of battleships in relation to sea-power? Do their numbers come up to the standard established by the Admiralty principle to which I have referred? Let us attempt to get a rough-and-ready estimate of our educational position by counting universities as the Admiralty counts battleships. I say rough and ready because we have other helps to greater brain-power to consider besides universities, as the Admiralty has other ships to consider besides ironclads.

In the first place, let us inquire if they are equal in number to those of any two nations commercially competing with us.

In the United Kingdom, we had until quite recently thirteen.† Of these, one is only three years old as a teaching university and another is still merely an examining board.

In Germany there are twenty-two universities; in France, under recent legislation, fifteen; in Italy twenty-one. It is difficult to give the number in the United States, because it is clear, from the tables given in the Report of the Commissioner of Education, that some colleges are more important than some universities, and both give the degree of Ph.D. But of universities in title we have 134. Among these, there are forty-six with more than fifty professors and instructors, and thirteen with more than 150. I will take that figure.

Suppose we consider the United States and Germany our chief commercial competitors, and apply the Admiralty principle. We should require, allowing for population, eight additional universities at the very lowest estimate.

We see, then, that instead of having universities equalling in number those of two of our chief competitors together, they are by no means equal to those of either of them singly.

After this statement of the facts, anyone who has belief in the importance of higher education will have no difficulty in understanding the origin of the present condition of British industry and its constant decline, first in one direction and then in another, since the tremendous efforts made in the United States and Germany began to take effect.

If, indeed, there be anything wrong about the comparison, the error can only arise from one of two sources; either the

† These are Oxford, Cambridge, Durham, Victoria, Wales, Birmingham, London, St. Andrews, Glasgow, Aberdeen, Edinburgh, Dublin and Royal University.

Admiralty is thoughtlessly and wastefully spending money, or there is no connection whatever between the higher intelligence and the prosperity of a nation. I have already referred to the views of Mr. Chamberlain and Lord Rosebery on this point; we know what Mr. Chamberlain has done at Birmingham; we know the strenuous efforts made by the commercial leaders of Manchester and Liverpool; we know, also, the opinion of men of science.

If while we spend so freely to maintain our sea-power our export of manufactured articles is relatively reduced because our competitors beat us in the markets of the world, what is the end of the vista thus opened up to us? A Navy growing stronger every year and requiring larger votes to guard our commerce and communications, and a vanishing quantity of commerce to guard—a reduced national income to meet an increasing taxation!

The pity is that our government has considered sea-power alone; that while so completely guarding our commerce, it has given no thought to one of the main conditions on which its production and increase depend: a glance could have shown that other countries were building universities even faster than they were building battleships; were, in fact, considering brain-power first and sea-power afterwards.

Surely it is my duty as your President to point out the danger ahead if such ignoring of the true situation should be allowed to continue. May I express a hope that at last, in Mr. Chamberlain's words, 'the time is coming when Governments will give more attention to this matter'?

WHAT WILL THEY COST?

The comparison shows that we want eight new universities, some of which, of course, will be colleges promoted to university rank and fitted to carry on university work. Three of them are already named: Manchester, Liverpool, Leeds.

Let us take this number and deal with it on the battleship condition, although a modern university on American or German models will cost more to build than a battleship.

If our present university shortage be dealt with on battleship conditions, to correct it we should expend *at least* 8,000,000*l.* for new construction, and for the pay-sheet we should have to provide ($8 \times 50,000l.$) 400,000*l.* yearly for personnel and up-keep, for it is of no use to build either ships or universities without manning them. Let us say, roughly, capitalizing the yearly payment at $2\frac{1}{2}$ per cent., 24,000,000*l.*

At this stage, it is important to inquire whether this sum, arrived at by analogy, merely, has any relation to our real university needs.

I have spent a year in making inquiries, as full as I could make them, of friends conversant with the real present needs of each of the universities old and new; I have obtained statistics which would fill a volume, and personally I believe that this sum at least is required to bring our university system up to anything like the level which is insisted upon both in the United States and in Germany. Even Oxford, our oldest university, will still continue to be a mere bundle of colleges, unless three millions are provided to enable the university properly so-called to take her place among her sisters of the modern world; and Sir Oliver Lodge, the principal of our very youngest university, Birmingham, has shown in detail how five millions can be usefully and properly applied in that one locality, to utilize for the good of the nation the enthusiasm and scientific capacity which are only waiting for adequate opportunity of development.

How is this money to be raised? I reply

without hesitation, *duplicate the Navy Bill of* 1888–9; do at once for brain-power what we so successfully did then for sea-power.

Let 24,000,000*l*. be set apart from one asset, our national wealth, to increase the other, brain-power. Let it be assigned and borrowed as it is wanted; there will be a capital sum for new buildings to be erected in the next five or ten years, the interest of the remainder to go towards increased annual endowments.

There need be no difficulty about allocating money to the various institutions. Let each university make up its mind as to which rank of the German universities it wishes to emulate. When this claim has been agreed to, the sums necessary to provide the buildings and teaching staff of that class of university should be granted without demur.

It is the case of battleships over again, and money need not be spent more freely in one case than in the other.

Let me at once say that this sum is not to be regarded as practically gone when spent, as in the case of a short-lived ironclad. *It is a loan* which will bear a high rate of interest. This is not my opinion merely; it is the opinion of those concerned in great industrial enterprises and fully alive to the origin and effects of the present condition of things.

I have been careful to point out that the statement that our industries are suffering from our relative neglect of science does not rest on my authority. But if this be true, then if our annual production is less by only two millions than it might have been, having two millions less to divide would be equivalent to our having forty or fifty millions less capital than we should have had if we had been more scientific.

Sir John Brunner, in a speech connected with the Liverpool School of Tropical Medicine, stated recently that if we as a nation were now to borrow ten millions of money in order to help science by putting up buildings and endowing professors, we should get the money back in the course of a generation a hundredfold. He added that there was no better investment for a business man than the encouragement of science, and that every penny he possessed had come from the application of science to commerce.

According to Sir Robert Giffen, the United Kingdom as a going concern was in 1901 worth 16,000,000,000*l*.

Were we to put aside 24,000,000*l*. for gradually organizing, building and endowing new universities, and making the existing ones more efficient, we should still be worth 15,976,000,000*l*., a property well worth defending by all the means, and chief among these brain-power, we can command. If it be held that this, or anything like it, is too great a price to pay for correcting past carelessness or stupidity, the reply is that the 120,000,000*l*. recently spent on the navy, a sum five times greater, has been spent to correct a sleepy blunder, not one whit more inimical to the future welfare of our country than that which has brought about our present educational position. We had not sufficiently recognized what other nations had done in the way of ship building, just as until now we have not recognized what they have been doing in university building.

Further, I am told that the sum of 24,000,000*l*. is less than half the amount by which Germany is yearly enriched by having improved upon our chemical industries, owing to our lack of scientific training. Many other industries have been attacked in the same way since, but taking this one instance alone, if we had spent this money fifty years ago, when the Prince Consort first called attention to our backwardness,

the nation would now be much richer than it is, and would have much less to fear from competition.

Suppose we were to set about putting our educational house in order, so as to secure a higher quality and greater quantity of brain-power, it would not be the first time in history that this has been done. Both Prussia after Jena and France after Sedan acted on the view:

> "When land is gone and money spent,
> Then learning is most excellent."

After Jena, which left Prussia a 'bleeding and lacerated mass,' the King and his wise counsellors, among them men who had gained knowledge from Kant, determined, as they put it, 'to supply the loss of territory by intellectual effort.'

What did they do? In spite of universal poverty, three universities, to say nothing of observatories and other institutions, were at once founded, secondary education was developed, and in a few years the mental resources were so well looked after that Lord Palmerston defined the kingdom in question as 'a country of damned professors.'

After Sedan, a battle, as Moltke told us, 'won by the school-master,' France made even more strenuous efforts. The old University of France, with its 'academies' in various places, was replaced by fifteen independent universities, in all of which are faculties of letters, sciences, law and medicine.

The development of the University of Paris has been truly marvellous. In 1897–8, there were 12,000 students, and the cost was 200,000*l*. a year.

But even more wonderful than these examples is the 'intellectual effort' made by Japan, not after a war, but to prepare for one.

The question is, shall we wait for a disaster and then imitate Prussia and France? or shall we follow Japan, and thoroughly prepare by 'intellectual effort' for the industrial struggle which lies before us?

Such an effort seems to me to be the first thing any national or imperial scientific organization should endeavor to bring about.

RESEARCH.

When dealing with our universities, I referred to the importance of research, as it is now generally acknowledged to be the most powerful engine of education that we possess. But education after all is but a means to the end which, from the national point of view, is the application of old and the production of new knowledge.

Its national importance apart from education is now so generally recognized that in all civilized nations except our own means of research are being daily more amply provided for all students after they have passed through their university career, and more than this, for all who can increase the country's renown or prosperity by the making of new knowledge upon which not only commercial progress, but all intellectual advance must depend.

I am so anxious that my statement of our pressing, and indeed imperative, needs in this direction should not be considered as resting upon the possibly interested opinion of a student of science merely, that I must trouble you with still more quotations.

Listen to Mr. Balfour:—

"I do not believe that any man who looks round the equipment of our universities or medical schools, or other places of education, can honestly say in his heart that we have done enough to equip research with all the costly armory which research must have in these modern days. We, the richest country in the world, lag behind Germany, France, Switzerland and Italy.

Is it not disgraceful? Are we too poor or are we too stupid?"*

It is imagined by many who have given no thought to the matter that this research should be closely allied with some application of science being utilized at the time. Nothing could be further from the truth; nothing could be more unwise than such a limitation.

Surely all the laws of nature will be ultimately of service, and, therefore, there is much more future help to be got from a study of the unknown and the unused than we can hope to obtain by continuing the study of that which is pretty well known and utilized already. It was a King of France, Louis XIV., who first commended the study of the *même inutile*. The history of modern science shows us more and more as the years roll on the necessity and advantage of such studies, and, therefore, the importance of properly endowing them, for the production of new knowledge is a costly and unremunerative pursuit.

Years ago we had Faraday apparently wasting his energies and time in playing with needles; electricity now fills the world. To-day men of science in all lands are studying the emanations of radium; no research could be more abstract; but who knows what advance in human thought may follow or what gigantic world-transforming superstructure may eventually be raised on the minute foundation they are laying?

If we so organize our teaching forces that we can use them at all stages from the gutter to the university to sift out for us potential Faradays—to utilize the mental products which otherwise would be wasted—it is only by enabling such men to continue their learning after their teaching is over that we shall be able to secure the greatest advantage which any educational system can afford.

It is now more than thirty years ago that my attention was specially drawn to this question of the endowment of research, first by conversations with M. Dumas, the permanent secretary of the Academy of Sciences, who honored me by his friendship, and secondly by my association with Sir Benjamin Brodie and Dr. Appleton in their endeavors to call attention to the matter in this country. At that time a general scheme of endowment suggested by Dumas was being carried out by Duruy. This took the form of the 'Ecole spéciale des Hautes Etudes'; it was what our fellowship system was meant to be—an endowment of the research of post-graduate students in each seat of learning. The French effort did not begin then.

I may here tell, as it was told me by Dumas, the story of Léon Foucault, whose many discoveries shed a glory on France, and revived French industry in many directions.* In 1851, when Prince Napoleon was President of the Republic, he sent for Dumas and some of his colleagues and told them that during his stay in England, and afterwards in his study of the Great Exhibition of that year, he had found there a greater industrial development than in France, and more applications of science, adding that he wished to know how such a state of things could be at once remedied. The answer was that new applications depended upon new knowledge, and that, therefore, the most direct and immediate way was to find and encourage men who were likely by research in pure science to produce this new knowledge. The Prince President at once asked for names; that of Léon Foucault was the only one mentioned during the first interview.

* *Nature*, May 30, 1901.

* See *Proc. R. S.*, Vol. XVII., p. lxxxiii.

Some time afterwards, to be exact at about 11 in the morning of December 2, Dumas's servant informed him that there was a gentleman in the hall named Foucault who wished to see him, and he added that he appeared to be very ill. When shown into the study, Foucault was too agitated to speak, and was blind with tears. His reply to Dumas's soothing questions was to take from his pockets two rolls of bank notes amounting to 200,000 francs and place them on the table. Finally, he was able to say that he had been with the Prince President since 8 o'clock that morning discussing the possible improvement of French science and industry, and that Napoleon had finally given him the money requesting him to do all in his power to aid the State. Foucault ended by saying that on realizing the greatness of the task thus imposed upon him, his fears and feelings had got the better of him, for the responsibility seemed more than he could bear.*

The movement in England to which I have referred began in 1872, when a society for the organization of academical study was formed in connection with the inquiry into the revenues of Oxford and Cambridge, and there was a famous meeting at the Freemasons' Tavern, Mark Pattison being in the chair. Brodie, Rolleston, Carpenter, Burdon-Sanderson were among the speakers, and the first resolution carried was, 'That to have a class of men whose lives are devoted to research is a national object.' The movement died in consequence of the want of sympathy of the university authorities.*

In the year 1874 the subject was inquired into by the late Duke of Devonshire's Commission, and after taking much remarkable evidence, including that of Lord Salisbury, the Commission recommended to the Government that the then grant of 1,000*l.* which was expended, by a committee appointed by the Royal Society, on instruments needed in researches carried on by private individuals should be increased, so that personal grants should be made. This recommendation was accepted and acted on; the grant was increased to 4,000*l.*, and finally other societies were associated with the Royal Society in its administration. The committee, however, was timorous, possibly owing to the apathy of the universities and the general carelessness on such matters, and only one personal grant was made; the whole conception fell through.

Meantime, however, opinion has become more educated and alive to the extreme importance of research to the nation, and in 1891 a suggestion was made to the Royal Commission which administers the proceeds of the 1851 Exhibition that a sum of about 6,000*l.* a year available for scholarships should be employed in encouraging post-graduate research throughout the whole empire. As what happened is told in the 'Memoirs of Lord Playfair,' it is not indiscreet in me to state that when I proposed this new form of the endowment of research, it would not have surprised me if the suggestion had been declined. It was carried through by Lord Playfair's enthusiastic support. This system has been at work ever since, and the good that has been done by it is now generally conceded.

It is a supreme satisfaction to me to

* In order to show how history is written, what actually happened on a fateful morning may be compared with the account given by Kinglake:—"Prince Louis rode home and went in out of sight. Then for the most part he remained close shut up in the Elysée. There, in an inner room, still decked in red trousers, but with his back to the daylight, they say he sat bent over a fireplace for hours and hours together, resting his elbows on his knees, and burying his face in his hands" ('Crimean War,' I., p. 245).

* See *Nature*, November and December, 1872.

know that in this present year of grace the national importance of the study of the *même inutile* is more generally recognized than it was during the times to which I have referred in my brief survey, and, indeed, we students are fortunate in having on our side in this matter two members of His Majesty's Government, who two years ago spoke with no uncertain sound upon this matter.

"Do we lack the imagination required to show what these apparently remote and abstract studies do for the happiness of mankind? We can appreciate that which obviously and directly ministers to human advancement and felicity, but seem, somehow or another, to be deficient in that higher form of imagination, in that longer sight, which sees in studies which have no obvious, necessary or immediate result the foundation of the knowledge which shall give far greater happiness to mankind than any immediate, material, industrial advancement can possibly do; and I fear, and greatly fear, that, lacking that imagination, we have allowed ourselves to lag in the glorious race run now by civilized countries in pursuit of knowledge, and we have permitted ourselves so far to too large an extent to depend upon others for those additions to our knowledge which surely we might have made for ourselves." —Mr. Balfour, *Nature*, May 30, 1901.

"I would remind you that all history shows that progress—national progress of every kind—depends upon certain individuals rather than upon the mass. Whether you take religion, or literature, or political government, or art, or commerce, the new ideas, the great steps, have been made by individuals of superior quality and genius who have, as it were, dragged the mass of the nation up one step to a higher level. So it must be in regard to material progress. The position of the nation to-day is due to the efforts of men like Watt and Arkwright, or, in our own time, to the Armstrongs, the Whitworths, the Kelvins and the Siemenses. These are the men who, by their discoveries, by their remarkable genius, have produced the ideas upon which others have acted and which have permeated the whole mass of the nation and affected the whole of its proceedings. Therefore, what we have to do, and this is our special task and object, is to produce more of these great men."—Mr. Chamberlain, *Times*, January 18, 1901.

I finally come to the political importance of research. A country's research is as important in the long run as its battleships. The most eloquent teaching as to its national value we owe to Mr. Carnegie, for he has given the sum of 2,000,000*l*. to found a system of endowments, his chief purpose being, in his own words, 'to secure if possible for the United States of America leadership in the domain of discovery and the utilization of new forces for the benefit of man.'

Here is a distinct challenge to Britain. Judging by experience in this country, in spite of the magnificent endowment of research by Mond and Lord Iveagh, the only sources of possible competition in the British interest is the State, which certainly could not put the 1/8000 part of the accumulated wealth of the country to better use, for without such help both our universities and our battleships will become of rapidly dwindling importance.

It is on this ground that I have included the importance of endowing research among the chief points to which I have been anxious to draw your attention.

THE NEED OF A SCIENTIFIC NATIONAL COUNCIL.

In referring to the new struggle for existence among civilized communities, I pointed out that the solution of a large

number of scientific problems is now daily required for the State service, and that in this and other ways the source and standard of national efficiency have been greatly changed.

Much evidence bearing upon the amount of scientific knowledge required for the proper administration of the public departments and the amount of scientific work done by and for the nation was brought before the Royal Commission on Science presided over by the late Duke of Devonshire now more than a quarter of a century ago.

The Commission unanimously recommended that the State should be aided by a scientific council in facing the new problems constantly arising.

But while the home Government has apparently made up its mind to neglect the advice so seriously given, it should be a source of gratification to us all to know that the application of the resources of modern science to the economic, industrial and agricultural development of India has for many years engaged the earnest attention of the Government of that country. The Famine Commissioners of 1878 laid much stress on the institution of scientific inquiry and experiment designed to lead to the gradual increase of the food-supply and to the great stability of agricultural outturn, while the experience of recent years has indicated the increasing importance of the study of the economic products and mineral-bearing tracts.

Lord Curzon has recently ordered the heads of the various scientific departments to form a board, which shall meet twice annually, to begin with, to formulate a program and to review past work. The board is also to act as an advisory committee to the Government,* providing among other matters for the proper coordination of all matters of scientific inquiry affecting India's welfare.

* *Nature*, September 4, 1902.

Lord Curzon is to be warmly congratulated upon the step he has taken, which is certain to bring benefit to our great dependency.

The importance of such a board is many times greater at home, with so many external as well as internal interests to look after, problems common to peace and war, problems requiring the help of the economic as well as of the physical sciences.

It may be asked, What is done in Germany, where science is fostered and utilized far more than here?

The answer is, there is such a council. I fancy very much like what our Privy Council once was. It consists of representatives of the Ministry, the universities, the industries and agriculture. It is small, consisting of about a dozen members, consultative, and it reports direct to the Emperor. It does for industrial war what military and so-called defence councils do for national armaments: it considers everything relating to the use of brain-power in peace, from alterations in school regulations and the organization of the universities, to railway rates and fiscal schemes, including the adjustment of duties. I am informed that what this council advises generally becomes law.

It should be pretty obvious that a nation so provided must have enormous chances in its favor. It is a question of drilled battalions against an undisciplined army, of the use of the scientific spirit as opposed to the hope of 'muddling through.'

Mr. Haldane has recently reminded us that 'the weapons which science places in the hands of those who engage in great rivalries of commerce leave those who are without them, however brave, as badly off as were the dervishes of Omdurman against the Maxims of Lord Kitchener.'

Without such a machinery as this, how can our Ministers and our rulers be kept completely informed on a thousand things of vital importance? Why should our position and requirements as an industrial and thinking nation receive less attention from the authorities than the headdress of the Guards? How, in the words of Lord Curzon,* can 'the life and vigor of a nation be summed up before the world in the person of its sovereign' if the national organization is so defective that it has no means of keeping the head of the State informed on things touching the most vital and lasting interests of the country? We seem to be still in the Palæolithic age in such matters, the chief difference being that the sword has replaced the flint implement.

Some may say that it is contrary to our habit to expect the Government to interest itself too much or to spend money on matters relating to peace; that war dangers are the only ones to be met or to be studied.

But this view leaves science and the progress of science out of the question. Every scientific advance is now, and will in the future be more and more, applied to war. It is no longer a question of an armed force with scientific corps, it is a question of an armed force scientific from top to bottom. Thank God the Navy has already found this out. Science will ultimately rule all the operations both of peace and war, and therefore the industrial and the fighting population must both have a large common ground of education. Already it is not looking too far ahead to see that in a perfect State there will be a double use of each citizen, a peace use and a war use, and the more science advances the more the old difference between the peaceful citizen and the man at arms will disappear; the barrack, if it still exists, and the workshop will be assimilated, the land unit, like the battleship, will become a school of applied science, self-contained, in which the officers will be the efficient teachers.

* *Times*, September 30, 1902.

I do not think it is yet recognized how much the problem of national defence has thus become associated with that with which we are now chiefly concerned.

These, then, are some of the reasons which compel me to point out that a scientific council, which might be a scientific committee of the Privy Council, in dealing primarily with the national needs in times of peace, would be a source of strength to the nation.

To sum up, then. My earnest appeal to you is to gird up your loins and see to it that the science of the British Empire shall no longer remain unorganized. I have endeavored to point out to you how the nation at present suffers from the absence of a powerful, continuous, reasoned expression of scientific opinion, urging in season and out of season that we shall be armed as other nations are with efficient universities and facilities for research to uphold the flag of Britain in the domain of learning and discovery, and what they alone can bring.

I have also endeavored to show how, when this is done, the nation will still be less strong than it need be if there be not added to our many existing councils another, to secure that, even during peace, the benefits which a proper coordination of scientific effort in the nation's interest can bring shall not be neglected as they are at present.

Lest some of you may think that the scientific organization which I trust you will determine to found would risk success in working on such large lines, let me remind you that in 1859, when the late Prince Consort occupied this chair, he referred to 'impediments' in scientific prog-

ress, and said: "they are often such as can only be successfully dealt with by the powerful arm of the State or the long purse of the nation."

If the Prince Consort had lived to continue his advocacy of science, our position to-day would have been very different. His early death was as bad for Britain as the loss of a great campaign. If we can not regain what we have lost, matters can not mend.

I have done what I feel to be my duty in bringing the present condition of things before you. It is now your duty, if you agree with me, to see that it be put right. You can if you will.

Norman Lockyer.

THE EXPEDITION TO THE BAHAMA ISLANDS OF THE GEOGRAPHICAL SOCIETY OF BALTIMORE.

In October, 1902, a number of citizens of Baltimore met at the residence of Dr. Daniel C. Gilman and organized the Geographical Society of Baltimore. The officers elected at that time were:

President—Daniel C. Gilman.

Vice-Presidents—Bernard N. Baker, Rev. John F. Goucher and Lawrason Riggs.

Treasurer—Robert Garrett.

Secretary—George B. Shattuck.

The purpose of organizing this society was the accumulation and distribution of geographic knowledge. The society rapidly increased in numbers, and within a few weeks included about 1,750 members, most of them citizens of Baltimore. A course of six lectures was given before the society in one of the large auditoriums of Baltimore. Early in the winter steps were taken to equip an expedition which should visit the Bahama Islands for the sake of prosecuting scientific work in that region. Several thousand dollars were quickly raised from various sources and the writer was asked to act as director of this expedition.

A large two-masted sailing vessel was chartered, provisioned and equipped for the work in hand and left Baltimore on the evening of June 1. The expedition was gone two months, arriving in Baltimore on the morning of July 30. With the exception of the inevitable seasickness, which many of the party experienced on the way out, the health of the entire company was excellent, not a single case of sickness arising.

The governor and residents of the Bahama Islands were advised of the purpose of the expedition many weeks before it left Baltimore and cooperated in every way possible to make the work successful.

The Johns Hopkins University in Baltimore, the National Museum, the United States Coast and Geodetic Survey, Agricultural Department, United States Weather Bureau and the Fish Commission of Washington and the University of Iowa also cooperated by either men, equipment or advice toward the success of the expedition.

The tide gauge now in operation at Nassau and the magnetic instruments used throughout the cruise were kindly loaned by the United States Coast and Geodetic Survey. Deep-sea thermometers, seines and other paraphernalia for marine work were loaned by the Fish Commission. The kites for high atmospheric work were loaned by the United States Weather Bureau.

The men who composed the scientific staff and took part in the investigations are as follows:

Dr. George B. Shattuck, director and chief of geological staff.

Dr. B. L. Miller, associate professor in Bryn Mawr College, associate geologist.

Dr. Clement A. Penrose, vice-director and surgeon of the expedition, chief of the medical staff.

Messrs. H. P. Cole, E. B. Beasley and T. H. Coffin, of the Johns Hopkins Medical School, assistants to Dr. Penrose.

Dr. W. C. Coker, of the University of North Carolina, chief of the botanical staff.

Messrs. C. A. Shore and F. M. Haynes, of the University of North Carolina, botanical assistants.

Mr. Barton A. Bean, curator of fishes in the United States National Museum, chief of staff of marine zoology.

Messrs. J. B. Custis and J. A. Lewis, of Johns Hopkins, assistants in marine zoology.

Mr. J. H. Riley, curator in the United States Museum, chief of staff for land zoology.

Mr. S. H. Derickson, assistant in land zoology.

Dr. Oliver L. Fassig, section director of the United States Weather Bureau, chief of staff of climatology and physics.

Mr. J. E. Ruth, Johns Hopkins University, assistant in climatology and physics.

Mr. C. N. Mooney, United States Department of Agriculture, chief of the soil survey.

Messrs. J. C. Britton and E. C. Hughes, United States Department of Agriculture, assistants in soil survey.

Mr. J. M. Wright, Johns Hopkins, historian.

Mr. A. H. Baldwin, of Washington, artist.

Mr. Frank Gilmore, foreign correspondent.

The results of the expedition may be briefly summarized as follows:

GEOLOGICAL SURVEY.

Work of Previous Investigators.—Many geologists have visited the Bahama Islands in times past, have studied the geological formations with more or less care and have arrived at the following conclusions:

1. The material of which the Bahama Islands are built is wind-blown coral sand.

2. The islands were formerly very much more extensive than now.

3. They are gradually being depressed beneath the surface of the Atlantic Ocean.

4. They are gradually being eroded by the waves.

5. They are slowly being elevated.

It will be noticed that there are two opposing views here, namely, that the islands are undergoing subsidence, and second, that they are being elevated.

Conclusions Arising from the Present Survey.—The geology of the Bahama Islands is not difficult or extremely varied. It presents a number of most interesting problems and exhibits a number of most instructive types of topography. The present survey has been able to determine that the material composing the Bahama Islands is not entirely made up of wind-blown coral and lime sand, but the lower portions of many of the islands, extending up to ten or fifteen or twenty-five feet above the present level of mean tide, has been deposited by the ocean and contains marine organisms in large numbers. Above this lies the deposit of wind-blown material which has up to this time been regarded as the sole type of deposit visible throughout the archipelago.

In regard to the question of elevation or subsidence, the survey has determined that both processes have taken place. The islands were doubtless much higher at one time than to-day, and it is equally certain that they were formerly more depressed beneath the Atlantic Ocean than they are now. It is impossible to say whether they are being elevated or submerged at the present time, as the process is extremely slow at best, and can only be detected by careful measurement extending over long periods of time. It is for this reason and to settle this question that a bench mark and tide gauge have been erected at Nassau.

BOTANICAL SURVEY.

Previous Investigations on Plants.—A number of botanists have made more or less extensive investigations on the plants in the Bahama Islands, but as a rule their studies have tended toward purely systematic classification of the flowering plants and published lists of the same with their localities throughout the archipelago.

Present Botanical Survey.—The work of the present survey has been:

1. To supplement the systematic work of earlier investigators by visiting islands

heretofore unstudied and by collecting some five hundred or more plants for future study and report.

2. The collection and study of lower forms of plant life, such as seaweed, fresh- and salt-water algæ, fungi, lichens and myxomycetes. The work on this latter group is new, as none have heretofore been reported from the Bahama Islands and the present survey has secured about twenty or thirty species.

3. The principal work of the botanical survey, however, has been, not so much the systematic study of forms, as the study of plants in their adaptation to their environments, the grouping of plants in societies and on certain formations and soil types and the variation of the same plants under different conditions to special changes in environment. A large number of photographs of typical plants were also secured.

SURVEY OF MARINE LIFE.

Survey of Marine Fauna.—Much work has been done on the marine life of the Bahamas and many valuable results secured.

Present Survey.—The aims of the present survey have been:

1. To secure color sketches of a number of the most interesting and important fishes of the Bahama Islands which have not been figured from other waters.

2. To secure specimens of fishes for the United States National Museum.

3. The study of the distribution of the Bahama fishes in reference to other fishes of the West Indian waters.

4. In prosecuting this work the marine survey has secured a thousand or more specimens of marine life.

5. The artist has made about twenty-five color sketches of the fishes of the Bahama waters, certain of which will be published in color in the proposed report.

SURVEY OF LAND FAUNA.

Work of Previous Collectors.—The Bahama Islands have been exhaustively studied by zoologists in previous years and large collections of birds have been made from time to time. Notwithstanding these investigations, problems have constantly come to light which have required further study, and in order to prosecute this work short expeditions have been made to the Bahama Islands for special purposes, such as the study of the habits of certain birds and the collection of certain types of life.

Present Survey.—The objects of the present survey have been:

1. To augment the collection of the United States National Museum along certain lines in the types of reptiles, birds and mammals.

2. To note the habits of certain birds as occasion offered.

3. To collect especially bats for future study in the United States National Museum.

4. To secure as representative a collection as possible for display in one of the institutions of Baltimore city.

5. In prosecuting this work about two hundred and sixty skins of representative birds, a hundred specimens of reptiles and about three hundred mammals have been secured.

ATMOSPHERIC SURVEY.

Work of Previous Investigators.—Previous investigations have consisted of a comprehensive and excellent collection of daily weather observations which have been published from time to time and have afforded the basis of the present work.

Work of the Present Survey.—1. The discussion of previous observations.

2. The securing of a continuous record of climatic conditions by means of self-recording instruments in regard to pressure, temperature and humidity from the

date of the arrival of the expedition at Nassau to the time of its departure.

3. The flying of kites in order to make observations of meteorological conditions in the upper atmosphere. Six ascents have been made ranging in altitude from four thousand to eight thousand feet and excellent records have been secured in each one of these ascents. This work has never before been attempted in these latitudes. A most interesting feature of these kite investigations was the successful flight of a kite from the deck of a steam launch to the elevation of eight thousand feet in the open sea.

Survey of the Tide and Erection of Bench Mark.—This work is entirely new for the Bahama Islands, and as stated above has for its aim the solution of the problem whether the islands are being elevated or submerged. The bench mark erected at Nassau, as far as I know, is the first to be established throughout the West Indian region. The tide gauge which has been established is a self-recording instrument that will run for one year, and its records will afterwards be reduced and the computation of mean tide level for Nassau harbor will be determined by the United States Coast and Geodetic Survey.

MAGNETIC SURVEY.

Work of Previous Investigators.—In the past hundred years from twenty-five to thirty observations have been made at ten or twelve stations throughout the archipelago. These observations have been almost entirely confined to the observation of magnetic declination.

The Work of the Present Survey.—The work of the present survey has been:

To determine the declination, dip and intensity of the terrestrial magnetism at a number of points in the Bahama Islands, especially at points previously occupied. Full sets of observations have been made at Nassau, Watling's, Clarence Town and Abaco. These observations will be reduced by the United States Coast and Geodetic Survey.

MEDICAL SURVEY.

The medical staff has stopped at and examined from a medical and sanitary standpoint the following settlements on the different islands of the Bahamas: New Providence, including Nassau and the surrounding country, with especial attention to the hospitals, etc., several of the largest schools and a number of private cases shown through the courtesy of the resident physicians. The water supply from a number of wells in the hospital grounds, Nassau, Grants Town and other parts of the island have been examined chemically and microscopically.

At those settlements or islands where there were no resident physicians the medical and surgical equipment was carried on shore and free dispensaries opened up. In some cases where the ship was able to anchor close to the shore, free clinics were held on her decks or in the main cabin, especially whenever it was necessary to operate on any of the conditions met with. In the settlements where the resident physicians were found they were in all instances sought out and questioned concerning the nature of their practice, diseases found, their treatment, condition of the people, etc. The homes of the natives were studied from a sanitary standpoint, a number of their dwelling places entered and inspected and physical and blood examinations made.

In a brief summary it would be impossible to go into the special studies to be included in a future report on these islands, but in general we were much impressed with the following:

1. The prevalence of leprosy. This disease included the three types, anæsthetic,

mixed and tubercular. Little care is taken in the isolation of these cases, as they mix freely with their fellows in the ordinary routine of life. In one or two instances pilots who desired to take our ship into harbors were found to have leprosy in more or less advanced stages.

2. The much better physical types presented by the pure blacks or whites in contrast with those of mixed blood. This was true especially of the pure blacks, probably from the reason that they have intermarried less than pure whites. Arranging the natives in order from the standpoint of their immunity to disease, we would place the pure blacks first, the pure whites second and mixed types last.

3. The direct relation of health to food. The islands where most farming was done presented a better type of people than those relying chiefly on fishing and sea industry for support.

4. The great prevalence of locomotor ataxia, rheumatism, neuralgia, ainhum or ring-toe, genito-urinary diseases, including syphilis, gonorrhœa, etc., eye diseases, including pinguicula, pterygium, ophthalmia, gonorrhœa, etc., interstitial keratitis, cataracts and errors in refraction, muscle balance, etc., dyspepsias and some diarrhœa due to poor food and exposure.

5. The presence of the filariæ sanguinis in the blood of one of the patients examined in the Nassau hospital. This case is said to have come from Long Island.

6. One case of elephantiasis in the leg of a woman living at Current Settlement, Eleuthera.

7. The type of malaria. It showed the malignant variety of parasites in the blood, but was of a mild type and not typical in its behavior. This alone would make an interesting scientific investigation.

8. Distribution of mosquitoes. The mosquitoes have been studied at all the different places visited with the result that several known varieties and unknown species, at least to our collector, have been found, and the places where obtained carefully noted. This collection has been purchased by Dr. L. O. Howard and will be worked up by him.

9. Most interesting studies were made of the inhabitants of Hope Town, Abaco, in order to determine the amount of degeneracy due to close intermarrying. At the close of the Revolutionary War this settlement was peopled by tories from America who desired to continue under British rule. For over a hundred years the inhabitants of Hope Town have intermarried so closely that now a man is related to his wife by more than one line of relationship. Charts constructed by Dr. Penrose established this point. The result has been that frightful degeneracy has taken place, resulting in many disorders and serious bodily deformations.

In all over a thousand people were seen professionally, and although many of these were not given medicines, nevertheless a number, possibly one half, received treatment, medical or surgical and advice regarding living, food, general hygiene. The cleanliness of the people as a whole and their good health in spite of poor food much impressed us, due unquestionably to the balmy climate of the Bahamas and the fact that the settlements are not yet overcrowded.

Special examinations for conditions interesting to the expedition were made in one hundred and fifteen cases and records kept of each one. Forty-three blood examinations were made, some of these at night. Owing to the short stops at the different settlements it was impossible to follow the effect of treatment in many of the cases that came to us for assistance.

SOIL SURVEY.

The soil survey was also in advance of anything previously attempted in the Bahamas. The men who conducted the soil investigations were experts in their particular subject and have succeeded in collecting a vast amount of information for future study and investigation. In all six of the more important islands of the archipelago were mapped in detail in such a manner as to show distribution of the principal soil types. These will be reproduced in color in the report. A large number of chemical analyses were made in a temporary laboratory erected in Nassau, in order to determine those properties of the soils which are apt to be lost if the samples are allowed to stand for any length of time. In addition to these preliminary investigations, more elaborate ones will be conducted later, in order to determine other properties of the soils essential to successful agriculture. It is too early at the present time to discuss the results of the soil survey at length, but I feel at liberty to say that when investigations are carried to their conclusion most valuable information will be at hand to direct the farmers of the Bahamas along intelligent lines of agriculture.

HISTORICAL INVESTIGATION.

The work of examining the public records and writing the history of the Bahama Islands has been going steadily forward all summer. The historian did not cruise among the out islands with the rest of the members of the expedition, but remained at work at Government House, Nassau, where the official records were kindly placed at his disposal by the governor. His paper, when completed, will treat of the development of the Bahama Islands as a crown colony of Great Britain.

COMMERCIAL GEOGRAPHY.

Material has been collected for a chapter on the commercial geography of the islands. This will discuss not only the products of the islands, but also the exports and imports, means of communication, condition of the people, etc.

These results and many others which can not be mentioned in this brief notice will be duly set forth in a report which is now being prepared.

Geo. B. Shattuck,
Director Bahama Expedition.

SCIENTIFIC BOOKS.

The Theory of Optics. By Paul Drude. Translated from the German by C. R. Mann and R. A. Millikan. New York, Longmans, Green & Co. 1902. Pp. xxi + 546.

During the past thirty years the science of optics has developed with surprising rapidity; in fact, in few of the branches of science have greater and more far-reaching changes in the fundamental concepts been made. This rapidity of growth may be attributed in large measure to the inspiration derived from the fertile hypothesis that was first suggested by Faraday and afterwards worked out in detail by Maxwell; for it was this hypothesis that called the attention of physicists to the possibility of unifying the sciences of optics and electricity under a single theory and of thus treating them both as manifestations of the phenomena of a common medium, the ether. The experimental work that was undertaken for the purpose of testing this Faraday-Maxwell hypothesis has led to extensions and modifications of the original supposition until it has now developed into an extensive and well-established theory, namely, the electromagnetic theory of light.

To the student of modern physics some comprehension of this fascinating theory is indispensable; yet such comprehension has been difficult to obtain because the various fragments of the argument by which the theory has been built up have been scattered in the

scientific journals and have hence been inaccessible to many who might otherwise desire to study them. Hence the gathering together into one volume of the main points of that argument, together with a discussion of how they have been used in the establishment of that theory and of the present tendencies and possibilities of that theory, is performing a great service not only to those who desire to learn of the theory, but also to the theory itself, since such work must help to show where modification and extension of the theory are possible and desirable.

It was a desire to meet these needs both of the student and of the theory that led Professor Drude to undertake the production of the work before us. Hence the purpose of the book is to supply a modern text embracing the entire subject of optics, and to make possible a deeper insight into the modern theory of light.

In order to attain this purpose, the author omits most of the older historical references, and gives only those later ones that will prove useful to the reader in finding the more extended discussions in the periodical literature. In fact, the greater part of the book treats of the work done during the last fifteen or twenty years. Hence it differs essentially from other treatises, many of which mention only the work done previous to the last fifteen or twenty years. Thus the discussion of the various mechanical theories of light, with their perplexities as to a mechanically incompressible ether and their shrewd and subtile attempts to annihilate the longitudinal vibrations by assumptions that lead to worse complications, give place in this book to a presentation of the electromagnetic theory, to a tracing of that theory in its consequences, and to a discussion of the problems that are now being solved or that ought to be solved in the near future.

In order to give the reader some idea of the nature of the questions discussed, a few of the more interesting ones will be mentioned. In the chapter on physical conditions for image formation the modern method of attacking the problems of spherical and chromatic aberration is discussed. The chapter on interference contains a presentation of the manner in which interference is used for obtaining high spectroscopic resolution by introducing a great difference of path between the two interfering beams, and discusses the problems of molecular vibrations to which this use of interference leads. The chapter on diffraction takes up not only the regular treatment of the grating, etc., but also goes into the question of resolving power in general, and the limit of resolution of optical instruments. In the chapter on absorbing media the reader learns of the optical properties of the metals and of the relations that have been established and proposed between the optical and electrical constants. The chapter on dispersion is particularly well done. Starting with the assumption that the smallest particles of a body possess natural periods of vibration, Professor Drude shows how these natural periods of the particles are involved with the period impressed upon the body from without and the index of refraction and the dielectric constant in determining when the dispersion is normal and when anomalous. He also shows how from the observed dispersion, together with other optical and electrical constants of a substance, the position of the absorption bands may be calculated. In the chapter on bodies in motion the reader is introduced to the present state of scientific opinion upon the questions: 'Is the ether at rest? Is its state of rest disturbed by the motion of matter through it?' His attention is also called to the points that need further investigation and discussion. The last portion of the book is given up to a presentation of the relations that have been discovered between thermodynamics and optics. Here important questions concerning the efficiency of a source of light and the conversion of other forms of energy into light are discussed. The last chapter takes up the properties of incandescent vapors and gases and presents the electron theory, calculating the probable size of an electron from optical data. This last portion of the book contains descriptions of work and theories that are not discussed extensively in any other English text.

A glance at the list of questions just pre-

sented must convince the reader that the topics discussed in the book are not only most interesting, but are also those with which science is to-day grappling. The method of presentation is also forceful, since it gains power and simplicity because of the unifying influence of the great theory that pervades it throughout. By thus giving a coherent treatment of the problems that are in process of solution at the present moment, Professor Drude has produced a book that is bound to have great influence for good upon the science of optics, since it must impress the student that, to use the author's own words, 'optics is not an old worn-out branch of physics, but in it there pulses a new life.'

In doing this the author has in addition given a valuable hint to writers of texts—for how much greater would be the interest in physical science among the people generally if many of the time-worn, cut-and-dried (particularly dried) discussions that have clung tenaciously to the texts could be rewritten so as to present the subject entirely from the present and future point of view instead of from that of the past? In such a presentation stress would be laid, as Professor Drude has done, not only upon that which had been settled, but also upon that which still remains to be settled; so that the reader would not be tempted, after reading the book, to think that he knows it all, since everything is finally settled and he can and has committed it to memory.

Thus all students of physics owe a debt of gratitude to the author of this 'Theory of Optics,' not only because he has woven together for them the scattered threads of the electromagnetic theory into a web of pleasing and symmetrical pattern, but also because he has, in so doing, shown how to present a scientific subject in such a way that the student is left with a realization of the fact that the science is alive and teeming with future possibilities, instead of with a feeling of disgust at having had thrust upon him the usual glorified and embalmed image of past grandeur—a corpse fixed in death.

Thus this work impresses us as a very able and original presentation of a difficult subject. We, therefore, welcome it as a distinct addition to the literature of optics. We congratulate the publisher on having made this book accessible to those to whom German is a barrier. They could perform another service to science if they could persuade Professor Drude to revise his earlier work on the 'Physics of the Ether,' for this work helps much in the understanding of his 'Theory of Optics.'

C. R. Mann.

University of Chicago,
September, 1902.

Medical Microscopy. By T. E. Oertel, M.D. Philadelphia, P. Blakiston's Son & Co. 1902. Small 8vo. Pp. 362.

The facts which a working knowledge of microscopy may reveal to aid in diagnosis are so important that the profession demands an acquaintance with this subject which is coming to be recognized more and more as fundamental in medicine.

This small volume is offered in response to a legitimate voice, as the author believes, coming especially from that part of the medical profession which graduated before much instruction was given in the subjects in which the microscope serves so great a purpose.

Naturally the microscope is the first to receive attention. The various parts are named and their functions explained. The terms used in manipulation are defined and some of the phenomena are considered.

The summary of the facts regarding the habitat, pathogenesis, morphology and cultural characteristics of many of the more important pathogenic bacteria will be of much assistance to those unfamiliar with the subject. The following topics are also briefly treated: preparation of tissue, tumors, blood and the various secretions and excretions of the body.

An author is certainly justified in compiling a work upon medical microscopy in order that the rudiments of the somewhat scattered knowledge may be accessible to all, yet, on the other hand, when such a book compiled from works upon subjects which are experiencing such rapid changes and additions reaches the reader, there will be an opportunity to take exceptions to certain portions of it. This

book is unfortunate in this respect. The technique suggested in many cases, doubtless, will not be received with favor by experienced laboratory workers.

Claim to originality is made by the author with respect to the presentation of the subject only. On the whole, the book is written in a style which is clear and concise. Some of the unqualified statements should be modified to meet the prevailing opinion of to-day. To aid in a future edition we should call attention also to the lettering of the diagrams to represent optical phenomena of the microscope, which we believe to be inadequate and confusing.

A book compiled on the plan of this one will do good service in the place to which the author in the preface modestly assigns it: 'It is to the beginner in microscopy, and particularly to him who must work without the personal guidance of a teacher, that the book may prove of value.'

G. FRANKLIN WHITE.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Journal of Mathematics for October contains the following articles: 'The Plane Geometry of the Point in Point-Space of Four Dimensions,' by C. J. Keyser; 'On the Functions Representing Distances and Analogous Functions,' by H. F. Blichfeldt; 'Surfaces whose Lines of Curvature in One System are Represented on the Sphere by Great Circles,' by L. P. Eisenhart; 'On the Invariants of a Homogeneous Quadratic Differential Equation of the Second Order,' by D. R. Curtiss; 'Surfaces of Constant Mean Curvature,' by L. P. Eisenhart.

SOCIETIES AND ACADEMIES.

MICHIGAN ORNITHOLOGICAL CLUB.

AFTER a few years of apparent sleep, the Michigan Ornithological Club was reorganized at Detroit on February 13, 1903. The officers elected for the current year are: *President,* Adolphe B. Covert, Ann Arbor; *Vice-President,* Dr. Phillip E. Moody, Detroit; *Secretary-Treasurer,* Bradshaw H. Swales, Detroit. Two permanent committees were created. The committee on Geographical Distribution consists of Dr. Charles C. Adams (chairman), Ann Arbor; Professor Walter B. Barrows, Agricultural College; Bryant Walker and B. H. Swales, of Detroit. The Bird Protection Committee consists of Edward Arnold (chairman), Battle Creek; Professor Walter B. Barrows, Agricultural College; James B. Purdy, Plymouth, to act in conjunction with Wm. Dutcher, chairman of the Protection Committee of the American Ornithologists' Union.

It was decided to continue the former club journal styled the *Bulletin of the Michigan Ornithological Club,* three numbers of which (Vol. IV.) have appeared so far. Alexander W. Blain, Jr., was made editor and business manager, and later J. Claire Wood, of Detroit, and Adolphe B. Covert, of Ann Arbor, were elected associates. The *Bulletin* is published by the club at Detroit as an illustrated quarterly devoted to the ornithology of the Great Lake region.

The prospects for the Ornithological Club in the Wolverine state seem most bright, and the society already has over one hundred members enrolled. Monthly meetings are held on the first Friday of each month at the Detroit Museum of Art and annual meetings will be held at the same time and place as the annual meeting of the Michigan Academy of Science.

ALEX. W. BLAIN, JR.

DETROIT COLLEGE OF MEDICINE.

DISCUSSION AND CORRESPONDENCE.

MICHIGAN PLANT SOCIETIES AGAIN.

THE thorough remodeling which my paper on the upland plant societies of Kent County, Mich.,* received at the hands of Mr. Francis Daniels in SCIENCE for August 14, 1903, makes this note by the author seem necessary. In the first place, I hasten to acknowledge with thanks the two very bad blunders which the reviewer has pointed out. *Quercus ilicifolia* should read *Q. prinoides,* and *Vitis cordifolia* should be replaced by *V. riparia.*

In the original paper the author expressly

* Annual Report State Board of Geol. Survey, Mich., 1901, pp. 81–103. *Botanical Gazette,* **35**: 36–55. 1903.

denied all pretense to finality of conclusions; it was to get light on just those subtile changes of soil, etc., to which Mr. Daniels alludes, that the work was undertaken. Thus the criticism that we can not point out any single cause for any difference in vegetation is hardly to the point. My critic deals only with the societies, he is willing to leave the description of soils as it was published.

That the societies used are not of equal rank was pointed out by the author. Increased complexity would doubtless be accompanied in some measure by increased accuracy, but the main points would thus be almost surely lost sight of in the maze of classification. The systematist born and bred can seldom understand the horribly slipshod ways of the ecologist! The fact that Mr. Daniels puts the beech-maple and the maple-elm-agrimony societies together shows clearly that he has failed to study the southern townships. Farther north these types do tend to merge, but southward, into Indiana and Illinois, they are still distinct, as more recent studies by the author show. Likewise, the combining of the oak-hickory with the oak-hazel society indicates failure to study well the condition of things in the northern part of the county. The presence or absence of hickory in this region involves one of the most important ecological questions, one which we can not interpret clearly as yet, but one which it can do no good to slur over. On the whole, my critic's description agrees fairly well with the conditions in the central townships, but fails altogether to express the facts throughout the county as a whole. This is one of the dangers which he might be warned against, namely, that of generalizing from too small an area, no matter how many years he has botanized in it. The author must admit that he, too, is a native of Kent County, and that he has studied its flora for many years.

Bidens frondosa and *Solanum nigrum* are 'frequent everywhere' only in the moister soils of the Grand River valley. *Nepeta, Phytolacca* and *Euphorbia corrallata* are, throughout the area, among the most constant and characteristic members of their societies; they are not weeds excepting in areas where they originally occurred. *Echinospermum* occurs in the lowlands, a fact which may have misled Mr. Daniels, but on the uplands it is a truly characteristic plant of the most mesophytic society. Regarding the distribution of *Cenchrus* there is need of more study than either Mr. Daniels or myself has yet accomplished. Wherever it comes from, it certainly occurs only on the worst sands, *i. e.*, only in the most xerophytic group. Occasional plants of *Dracocephalum* are to be found in the beech and maple forests south of the Grand River valley.

The societies are based on forms which are evident the year round, not on summer forms nor spring forms. Of the 140 forms listed, no less than 40 are spring-flowering. There doubtless are well-marked societies of Thallophytes and Bryophytes, but those of the two higher groups are the ones chosen for study. An adequate study of the distribution of grasses and sedges will be a work by itself when the right student undertakes it. These plants were purposely omitted from the paper under discussion.

BURTON EDWARD LIVINGSTON.
THE NEW YORK BOTANICAL GARDEN,
September 15, 1903.

SHORTER ARTICLES.

FOUR NEW SPECIES OF THE CENTRAL AMERICAN RUBBER TREE.

THOUGH still in the initial and experimental stage, the cultivation of rubber-producing trees is now attracting more general attention than any other branch of tropical agriculture. Large amounts of American capital are being invested in Mexico and Central America, and the practicability of rubber culture in the tropical islands of the United States is receiving the attention of the Department of Agriculture. The first studies have been directed to the Central American rubber tree (*Castilla*), and one of the facts established is the existence of several different local types, instead of a single species extending from Mexico to Bolivia, as hitherto supposed. The species of Castilla are among

the many plants for the study of which the usual dried and shriveled herbarium material is nearly worthless, but in deference to current botanical opinion the public has continued to infer that rubber planting is equally practicable in all localities in which wild trees are found, and that all trees are equally suitable for cultivation, except the elusive 'tunu' or 'ule macho' (male rubber), which Hemsley has recently attempted to separate as a distinct species.

Until the intervening territory has been thoroughly explored it can not be known with certainty whether two supposed species from distinct localities intergrade or not, but for agricultural purposes this is a matter of little importance. There are at least two different kinds of *Castilla* in cultivation in Mexico and two in Costa Rica, and the indications are that these four are distinct species. The *Castilla* introduced from Panama to Ceylon and other British colonies represents a fifth type, while three others are of merely botanical interest, as yet, since they are not known to produce commercial rubber.

Before touching upon the characters which distinguish the species, it may be well to explain that *Castilla* is partially diœcious, somewhat after the manner of the edible fig. The inflorescence consists, as in the fig, of a fleshy receptacle which bears either stamens or pistils; the pistillate inflorescence is turbinate, the staminate more or less flabellate or funnel-shaped. There are trees which bear only male inflorescences, or at least there are some which bear crops of males without females, but along with the females there are also male inflorescences, smaller and generally of a different shape from those of the male trees. The primary male inflorescences arise normally in groups of four, but of the secondary or complemental male inflorescences, those which subtend the females, there are never more than two, as though the female inflorescence were the equivalent of two male clusters.

The original description of *Castilla elastica* (the name *Castilloa* being an unwarranted emendation) was not accompanied by any indication of a definite locality, but there is every probability that Cervantes had reference to the *Castilla* of eastern Mexico, which seems to differ from all of its relatives in its robust habit and in the large size of its ripe fruits, which also have numerous and very distinct vertical grooves. Cervantes' plate shows, in addition, long, slender complemental male inflorescences.

The *Castilla* of the Soconusco district of the state of Chiapas (*C. lactiflua*) is peculiar in having the complemental inflorescence flattened and with a broad mouth; it is very similar to the primary except in the smaller size. The specific name alludes to the fact that the milk of the tree flows freely when the bark is cut, so that it can be collected in quantity and coagulated by improved 'creaming' methods instead of the rubber being harvested wholly or partly by pulling the 'scrap' (burucha) from the gashes in which it has dried. Large yields of scrap rubber are sometimes reported from wild trees, but the tapping to which they are subjected is very severe, and the removal of the rubber from the wounds delays healing and exposes the tree to the attacks of insects, so that the cultural production of scrap rubber is not likely to be profitable.

On the peninsula of Nicoya, which extends into the Pacific Ocean from the northern part of Costa Rica, is a rubber tree easily recognized by the dark olive color of its inflorescences of both sexes, and by the deeply bilobed, long-stalked primary male inflorescence; the complemental inflorescences are also long and slender and are usually grown together at the base. The branches, leaves and floral organs are also much more densely hairy than those of the *Castilla* or of the more humid eastern slope of Costa Rica (*C. costaricana* Liebmann). In *C. nicoyensis* the individual fruits are very prominent, as in the two Mexican species, but in *C. costaricana* they are separate only at the broadly rounded or flattened apex, leaving no characters by which Hemsley's *Castilla tunu*, from British Honduras, can be distinguished, except the reputed deficiency of rubber, which is by no means lacking in *C. costaricana*. It seems certain, however, the 'tunu' tree which Hemsley has recently figured and described from

materials collected by Professor H. Pittier at 'Quebrado de Potrero Grande,' in southern Costa Rica,* is quite distinct from the Belize *tunu.* The branches, leaves and fruits are only slightly hairy, the fruits, fruit-clusters and seeds are smaller, and the individual fruits are distinct to near the base. Professor Pittier also informs me that the habit of the tree is different from that of *C. costaricana,* and that the fruits do not become fleshy and soft with maturity, but simply dry up. The milk does not yield an elastic gum, but hardens into a substance which the natives call 'gutta-percha.' Since Hemsley refers to previous figures and descriptions by Hooker and himself as representing the Belize *tunu,* and places British Honduras as the first locality, it seems that the name *Castilla tunu* belongs to the more northern tree; for that of southern Costa Rica the name *Castilla fallax* is suggested.†

* Icones Plantarum, 7: pl. 2651. 1900.

† The diagnostic characters of the several species of *Castilla* are summarized in the following analytical key:

Pistillate inflorescence with a thick stipe 18–25 mm. long; stigmas short, cushion-shaped; pistils distinct to base. *Castilla australis* Hemsley; Peru.

Pistillate inflorescence sessile; stigmas slender; pistils coadnate, at least at base.

- Primary male inflorescence with a distinct slender stipe 15–20 mm. long; deeply bilobed and opening widely with maturity. *Castilla nicoyensis* sp. n.; Nicoya Peninsula.
- Primary male inflorescence broadly flabellate, gradually narrowed to the short stipe; not bilobed, opening only by a longitudinal slit.
  - Complemental inflorescence flabellate, broad and flattened like the primary, and with a broad longitudinal opening. *Castilla lactiflua* sp. n.; Soconusco, Mexico.
  - Complemental inflorescence obconic or pyriform, with a central aperture.
    - Ripe fruits very large and prominent, with numerous deep vertical grooves. *Castilla elastica* Cervantes; eastern Mexico.
    - Ripe fruits less prominent, the grooves shallow or wanting.
      - Leaves not cordate at base; leaves, branches and fruits nearly glabrous; fruits becoming tough and dry with maturity; seeds round, 6–7 mm. in diameter, male flowers with two stamens adnate at base. *Castilla fallax* sp. n.; southwestern boundary of Costa Rica.
      - Leaves distinctly cordate at base; leaves, branches and fruit densely hirsute, fruits becoming soft and deep orange or red with maturity; seeds oval or flattened 8–12 mm. in diameter; stamens 2 or 3, free.
        - Ripe fruits with prominent acute tips. *Castilla panamensis* sp. n.; Panama.
        - Ripe fruits with apices broadly rounded or flattened. *Castilla costaricana* Liebmann; eastern Costa Rica.

Some of Hooker's figures * ascribed to *Castilla elastica* may possibly represent *C. fallax,* but not those called *tunu* by Hooker and Hemsley. It seems, then, that the flat-fruited *C. tunu* Hemsley, from Belize, may be merely a subspecies under the older name *costaricana.* The Panama *Castilla* is also obviously related to *costaricana,* but the sharply pointed fruits may characterize a second subspecies, *C. panamensis,* of which Hooker published an elaborate plate based on drawings made in Ceylon.†

Four other specific names have been used under *Castilla. C. markhamiana* Collins has been assigned by Hooker and Hemsley to the allied genus *Perebea.* Koschny's *C. alba, C. rubra* and *C. nigra,* from northeastern Costa Rica, seem likely to prove synonyms of *C. costaricana.* The bark characters relied upon by Herr Koschny ‡ as diagnostic are explainable on other grounds than that they constitute specific or even varietal differences.

The existence of numerous species and varieties of *Castilla* shows that careful discrimination will be necessary in selecting the type best adapted for cultivation in Porto Rico and the other tropical islands of the United States. It shows, too, that the rather ad-

* *Trans. Linn. Soc. London,* 2d series, **2**: 209, pl. 28, figs. 4–6. 1885.

† *Trans. Linn. Soc. London,* 2d series, **2**: 209, pl. 27. 1885.

‡ 'Beihefte zum Tropenpflanzer,' **2**: 124. 1901.

verse results of the East Indian experiments with *C. panamensis* may not apply to the whole genus. Moreover, during the present study of the subject many reasons have been found for believing that the conditions under which *Castilla* has been tested in the East Indies are not really favorable to the production of rubber; the current idea that a continuously humid climate is required is erroneous. In short, it appears that we are still at the beginning of a scientific comprehension of the factors which determine the practicability and profitability of rubber culture. It has been ascertained that rubber can be produced agriculturally, but where, how and what to plant, and how, how much and how long we shall harvest, are questions largely answered, as yet, by speculation rather than by experiment. O. F. COOK.

U. S. DEPARTMENT OF AGRICULTURE.

THE NAME OF THE BREADFRUIT.

THE genus *Artocarpus* was first described in 1776 by G. and G. J. R. Forster in the 'Characteres Generum Plantarum,' a work written as a result of their botanical studies made during Captain Cook's second voyage into the Pacific and round the world between 1772 and 1775. The combination *Artocarpus communis* was given in this work for the breadfruit tree, a name which, according to nomenclatorial rules, must replace the generally accepted *Artocarpus incisa,* which was not published by the younger Linnæus until 1781.*

Forster's genus was, moreover, published as a monotype, and as his plants were from the Society Islands there can be no doubt but that he was dealing with the true breadfruit. He did not publish, it is true, any specific description, leaving all for the genus, but he did make a good binomial combination and had two good plates which are generally considered sufficient to establish a name in good standing.

Thunberg later in the same year (1776) published the names *Radermachia incisa* and *integrifolia* for the bread- and jak-fruits respectively from material collected in the East Indian Islands. Five years afterwards the younger Linnæus made his new nomenclatorial combinations on this material of Thunberg, adopting Forster's generic name and adding to it Thunberg's specific designations, and taking the credit to himself.

* 'Suppl.' 411. 1781.

Further complications are met with when it is found that in the subsequent works of the Forsters, when mention is made of the breadfruit, the specific name *incisa* is used. Why they should abandon their own name is rather difficult to understand unless it was a case in which 'the king can do no wrong.'

Dr. A. Richter is fully alive to the injustice done Forster and has published a note* on the history of the name of the breadfruit which adequately states the facts in the case and further calls attention to the unfortunate revival by O. Kuntze of the pre-Linnæan name of *Soccus*, a relic of Rumphius, and of his combining with it Forster's specific name. Yet Rumphius published a specific name for the breadfruit which Kuntze has, for no apparent reason, seen fit to ignore.

A. Engler, acting on this note, has corrected in the 'Nachtrag' to the 'Natürlichen Pflanzenfamilien' the name of the breadfruit as it appears in the text of that work, and states that *Artocarpus communis* is the correct designation. HENRY E. BAUM.

U. S. DEPT. AGRICULTURE.

EUCALYPTS IN THE PHILIPPINES.

THE eucalypts, of which but comparatively few species are familiarly known outside of their native home, include some one hundred and fifty species or more, nearly all restricted to Australia and Tasmania. Many of the forms may be classed as shrubs, others attain great size, surpassing in height, as has been stated on good authority, the giant Sequoias of California, though not equaling them in diameter or girth. A few species have been found elsewhere, viz., in New Britain, New Guinea and Timor, islands north of the Australian continent, between latitude 10° S., and the equator. It is not unlikely that sooner or later other species, at present unknown, will be detected on some of the multi-

* *Botanisches Centralblatt* **60**: 169–170. 1894.

tude of islands, large and small, that occur between latitude 10° S., and 20° N. and longitude 90° to 170° E. From New Britain in the Bismarck archipelago midway between latitude 10° S. and the equator, to Mindanao, the most southern of the Philippines between latitude 5° and 10° N., situated to the northwest of New Britain, is quite a leap, as will be perceived by a moment's thought. The occurrence of *Eucalyptus* in the Philippine island above named has recently been verified by Mr. Maiden, the director of the Botanic Gardens, Sydney, N. S. W., who has examined the specimen collected by William Rich, the botanist of the U. S. ship *Relief* of the famous Wilkes* Exploring Expedition, who collected the plant or example, near Caldero, Mindanao, some time between 1838 and 1842, and named it *E. multiflora;* it proves, however, to be identical with *E. naudiniana* F. v. Müller.† Rich's name being preoccupied explains the change of name. *E. naudiniana* occurs in New Pommern (New Britain) 'and is so common in the forests that two saw-mills have been started especially for the timber, which is not hard as the Australian *Eucalyptus,* but still good useful timber.'‡

Robt. E. C. Stearns.

Los Angeles, Cal.,
August 15, 1903.

* *Proc. U. S. National Museum,* Vol. XXVI., p. 691.

† *Id.,* p. 692.

‡ As Mr. Maiden says: "There are so few Eucalypti found outside of Australia that the question of the identity of one found beyond the limits of that continent is of interest, and the occurrence of the genus in the Philippines is now set at rest, and doubtless its range in that group will be ascertained by American botanists."

QUOTATIONS.

LORD SALISBURY AS A MAN OF SCIENCE.

It is generally understood that the branch of science which Lord Salisbury loved best was chemistry, and the freedom with which he discussed chemical questions gives weight to the suggestion. Besides, it is well known that he spent much time in his laboratory in Hatfield House, where, however, he directed his attention also to engineering and electrical problems. He conceived the idea of utilizing the flow of the River Lea for the electric lighting of the house, and the provision of a water supply to the town of Hatfield from the mains of Hatfield Park was due to his thought and kindliness.

In many ways he showed that his love of science had practical as well as academic leanings, but he made no original communication on scientific subjects to the learned societies. He was elected to the fellowship of the Royal Society in 1869, and almost immediately became a member of the council. He took a keen and active interest in the internal affairs of the Royal Society, for he served on the council in 1882–3, and again in 1892–4. He was vice-president also in 1882–3, and in 1893–4. And almost his last public act was associated with science and not with politics, for on the occasion of the election of the Prince of Wales to the fellowship of the Royal Society in April last it was Lord Salisbury who introduced him to the president and fellows.

Lord Salisbury's character as a man of science deservedly secured for him the particular respect and admiration of our profession, though it must be confessed that he made no bid whatever for our favor. Lord Salisbury's name is not associated with a singular popular measure of the kind that would be sure to win medical approbation. But medical men could see in his attitude toward life the trained and austere thinker. He did not speak if he did not know; he would not proceed to the next step till he had verified the one on which progress should depend; and, having convinced himself in which direction truth lay, he would hold firmly to his convictions.—*The Lancet.*

CIVIL ENGINEERS OF THE NAVY.

The civil engineers of the navy seem to have a substantial grievance. The service has grown and with it the duties of these dockyard officials. Our navy repair shops do an infinitely larger business than at any time since the war for the union. The civil engineer at Norfolk, for instance, has under his charge public works involving an expenditure of $2,700,000, and is also responsible

for the repairs to and preservation of property valued at $2,500,000. His brother officer at New York is supervising the investment of appropriations amounting to $4,500,000, and is responsible for property estimated to be worth $7,000,000. Yet his rank is only that of a lieutenant-commander, while the officer at Norfolk is merely a junior lieutenant. It is also a fact that there are but thirty-one officers in the corps, of whom one is Peary, who has been away from his regular duties, in the interest of science, for a number of years and who is about to go again. Promotion, too, is very slow. As the corps now stands, two of the junior lieutenants will not become full lieutenants until the age of fifty-nine, when they may, perhaps, be grandfathers. Altogether, it seems plain that if more rank and pay are to be bestowed anywhere in our rapidly expanding navy the civil engineers ought to be the first considered. Efficient men in this corps should mean better navy yards and docks, and so greater economies in the interest of the taxpayers.—New York *Evening Post.*

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*GEOLOGICAL EXPLORATIONS IN EGYPT.**

Thanks to the munificence of Mr. W. E. de Winton, who generously undertook to defray the entire cost of carrying on for one or two seasons geological explorations in the Libyan Desert, the trustees of the British Museum have been enabled, as the result of the past season's operations, to enrich considerably the national collection of fossils in the Natural History Museum. Dr. C. W. Andrews, of the geological department, was again sent on this mission, and he received valuable assistance from Captain H. G. Lyons, director-general of the Egyptian Geological Survey, and other officers of the survey. Dr. Andrews proceeded to the Fayûm and began work in the district to the north of the lake Birket-el-Kerun; and here he secured a fairly large collection of vertebrate remains, including several new forms and some specimens of great scientific interest, nearly all the bones being of Upper Eocene age.

* From the London *Times.*

The most important object obtained is a very fine and almost complete skull and mandible of a large, heavily-built ungulate, the first specimen of which was discovered two years ago by Mr. H. J. L. Beadnell, of the Egyptian Geological Survey, who called the genus *Arsinoitherium* (after Arsinoë, a queen of the Fayûm in the 3d century B. C.), naming the species Zitteli, after Professor K. von Zittel, the distinguished paleontologist at the University of Munich, and a pioneer of geological exploration in the Libyan Desert. *Arsinoitherium* probably resembled in general appearance a big rhinoceros, though in no way related to that animal. The form of the bones of the feet and legs suggests that it was most nearly allied to the elephants and to the Dinocerata, a remarkable group of huge extinct herbivorous hoofed mammals, remains of which have been found in great abundance in the Eocene Tertiary strata of Wyoming, North America; but in the possession of a pair of great bony horns over the nose, together with a smaller pair over the eyes and in the peculiar form of the teeth *Arsinoitherium* stands quite apart from other mammals.

Dr. Andrews also came across a very large mandible and a maxilla, both with well preserved teeth, which have characters indicating the existence of a species of *Arsinoitherium* much bigger than the one named after Zittel.

Of the early and primitive forms of Proboscidea a considerable series of specimens was acquired for the national collection at South Kensington. Mention may be specially made of a nearly complete skull of *Paleomastodon,* one of the early forms of the elephant family lately found in the Eocene beds of Egypt. It is of interest to note that most of the characters which give to the skull and teeth of the modern elephant their peculiar structure and appearance have in *Paleomastodon* only just begun to develop. Thus as regards the teeth, the grinders are much simpler than in later forms, and consist of three transverse ridges only. Moreover, all the cheek-teeth (premolars and molars) are in wear at once, as in ordinary mammals, while in the recent elephants the front cheek-teeth fall out before the hinder ones are cut. The shortening

of the face and the swelling up of the hinder part of the skull are connected with the development of the heavy tusks and trunk of the present day elephant; but in *Paleomastodon* these structures were comparatvely small, and the animal must have presented much the appearance of a very large pig.

Peculiar interest attaches to the discovery of bones of a large Hyracoid about the size of a tapir, belonging to a new genus. It is only within recent years that fossil remains of this group of mammals, whose affinities have long been a puzzle to zoologists, have been described. Dr. Andrews relates the occurrence in these beds of four other species of *Hyraces;* and this fact would seem to indicate that the comparatively few and insignificant modern members of the group are the degenerate descendants of a once numerous stock which must at that time have been an important factor in the Ethiopian fauna.

The sands and clays in which these bones and fossilized trees are embedded in such abundance are evidence that in Eocene times this part of the Libyan Desert was the estuary of a great river, down which the carcasses of drowned animals, accompanied by big tree-trunks, were swept, and then buried in mud and sand.

Dr. Andrews also obtained a collection of specimens from the Pleistocene lake-beds of Birket-el-Kerun, including numerous flint implements and remains of an animal which he has identified as belonging to the African elephant (*Elephas Africanus*). The occurrence of elephant remains in this locality associated with flint implements is, as Dr. Andrews points out, very noteworthy, both as extending the known range of the African elephant and also as supplying a strong reason for regarding the implements as being of prehistoric age. Dr. Budge states that no representation of the elephant is met with on any of the early Egyptian monuments, which certainly would not be the case had the artists been familiar with the animal; and it is therefore probable that it became extinct in Egypt at some remote prehistoric period, when also the implements which were found with the remains must have been made.

The imposing-looking skull of *Arsinoitherium Zitteli* and specimens of *Paleomastodon* are now exhibited in the Central Hall of the Natural History Museum.

Mention may also be made here of other recent important additions to the exhibited collection in the gallery of fossil mammalia. These comprise a series of remains of mammals from the Lower Pliocene formation of Pikermi, near Athens, obtained during the excavations recently undertaken by the trustees at that place. The bones exhibited are only a small portion of the large collection secured by Dr. A. S. Woodward. They represent quadrupeds which were living in Greece in the Lower Pliocene period, when that country was connected by land with Asia and Africa, before the Mediterranean assumed its present form. Greece was then a land of forests, table-lands and lakes; and Pikermi is part of the bed of a silted-up lake, into which the bones of accidentally destroyed herds of quadrupeds were washed and buried. The remains shown at South Kensington belong to primitive elephants (*Mastodon*), rhinoceroses, three-toed horses (*Hipparion*), numerous antelopes, giraffes, pigs, hyenas and monkeys. Attention should be drawn to the instructive pieces of the bone-beds showing how the fossilized remains occur in the rock.

THE ELIZABETH THOMPSON SCIENCE FUND.

This fund, which was established by Mrs. Elizabeth Thompson, of Stamford, Connecticut, 'for the advancement and prosecution of scientific research in its broadest sense,' now amounts to $26,000. As accumulated income will be available January next, the trustees desire to receive applications for appropriations in aid of scientific work. This endowment is not for the benefit of any one department of science, but it is the intention of the trustees to give the preference to those investigations *which can not otherwise be provided for,* which have for their object the advancement of human knowledge or the benefit of mankind in general, rather than to researches directed to the solution of questions of merely local importance.

Applications for assistance from this fund, in order to receive consideration, *must be accompanied by full information*, especially in regard to the following points:

1. Precise amount required. Applicants are reminded that one dollar ($1.00 or $1) is approximately equivalent to four English shillings, four German marks, five French francs, or five Italian lire.

2. Exact nature of the investigation proposed.

3. Conditions under which the research is to be prosecuted.

4. Manner in which the appropriation asked for is to be expended.

All applications should reach, before January 1, 1904, the Secretary of the Board of Trustees, Dr. C. S. Minot, Harvard Medical School, Boston, Mass., U. S. A.

It is intended to make new grants in January, 1904.

The trustees are disinclined, for the present, to make any grant to meet ordinary expenses of living or to purchase instruments, such as are found commonly in laboratories. Decided preference will be given to applications for small amounts, and grants exceeding $300 will be made only under very exceptional circumstances.

(Signed)

Henry P. Bowditch, *President*,
Charles S. Rackemann, *Treasurer*,
Edward C. Pickering,
Theodore W. Richards,
Charles-Sedgwick Minot, *Secretary*.

September, 1903.

Grants made prior to 1900 have already been printed in Science. The following grants have since been made.

1900.

86. $200, to Dr. H. H. Field, Zürich, Switzerland, to aid in the publication of a card catalogue of biological literature.

87. $500, to S. H. Scudder, Esq., Cambridge, Mass., for the preparation of an index to North American Orthoptera.

88. $300, to Professor P. Bachmetjaw, Sofia, Bulgaria, for researches on the temperature of insects.

89. $250, to Dr. E. S. Faust, Strassburg, Germany, for an investigation of the poisonous secretion of the skin of Amphibia.

90. $250, to Professor Jacques Loeb, Chicago, Ill., for experiments on artificial parthenogenesis.

91. $650, to the National Academy of Sciences, Washington, D. C., towards the expenses of three delegates to attend the conference of academies at Wiesbaden in October, 1899, to consider the formation of an International Association of Academies.

1901.

92. $150, to Professor E. W. Scripture, New Haven, Conn., for work in experimental phonetics.

93. $300, to Professor W. Valentiner, Heidelberg, Germany, for observations on variable stars.

94. $50, to A. M. Reese, Esq., Baltimore, Md., for investigation of the embryology of the alligator.

1902.

95. $125, to F. T. Lewis, M.D., Cambridge, Mass., for investigation of the development of the vena cava inferior.

96. $150, to Professor Henry E. Crampton, New York, for experiments on variation and selection in Lepidoptera.

97. $100, to Professor Frank W. Bancroft, Berkeley, Cal., for experiments on the inheritance of acquired characters.

98. $250, to Professor John Weinzirl, Albuquerque, N. M., for investigation of the relations of climate to the cure of tuberculosis.

99. $300, to Professor H. S. Grindley, Urbana, Ill., for investigation of the proteids of flesh.

100. $300, to Dr. Herbert H. Field, Zürich, Switzerland, to aid the work of the Concilium Bibliographicum. (An additional grant of $300 was made June, 1903.)

101. $250, to Dr. T. A. Jaggar, Cambridge, Mass., for experiments in dynamical geology.

102. $50, to Professor E. O. Jordan, Chicago, Ill., for the study of the bionomics of *Anopheles*.

103. $300, to Dr. E. Anding, Munich, Bavaria, to assist the publication of his work, 'Ueber die Bewegung der Sonne durch den Weltraum.'

104. $300, to Professor W. P. Bradley, Middletown, Conn., for investigations on matter in the critical state.

105. $300, Professor Hugo Kronecker, Bern, Switzerland, for assistance in preparing his physiological researches for publication.

106. $300, to Professor W. Valentiner, Heidelberg, Germany, to continue the work of Grant No. 93.

OBSERVATORY AND PHYSICAL LABORATORY AT WASHBURN COLLEGE.

Washburn College Observatory, Topeka, Kansas, was dedicated September 18. The address was delivered by Professor C. L. Doolittle of the Flower Observatory. The equipment now comprises the 11½-in. 'Grand Prix' refractor exhibited by Warner and Swasey at the Paris Exhibition, a five-inch photographic doublet, 7-centimeter combined transit and zenith telescope, sextant, mean time break circuit chronometer and a standard chronograph. There will be added at once a mean time and a sidereal clock, a position micrometer, a computing machine and a working library of star charts and catalogues, tables, standard works of reference and observatory publications. Provision is also made for a meridian circle and spectroscopic outfit. The dome is a 26-foot, copper covered, by Warner and Swasey. There is a dark room, a clock and reception room, an apparatus room, library and computing room, and recitation room. Adjacent to the observatory are the new physical laboratories and mathematical rooms. On the ground floor are the heat and electrical laboratories and shop; on the main floor the lecture-room, apparatus room, offices, general laboratory, light and spectroscopy room and a room for special or advanced work. Both the observatory and the laboratories are the gift of an eastern man who has not allowed his name to be announced in connection with the gift.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The attendance at the Southport meeting of the British Association was 1,754, consisting of 250 old life members, 21 new life members, 319 old annual subscribers, 90 new annual subscribers, 688 associates, 365 ladies, and 21 foreign members. This is slightly larger than the attendance at the Belfast meeting last year and is not far from the average of recent meetings, but falls short of the attendance of the Southport meeting of 1883 by nearly 1000. The International Meteorological Committee sat during the meeting of the British Association, the members being received by the Mayor of the city, previous to their session. The receipts of the Association last year were £4,117, and the expenditure £3,468, a balance being brought forward from last year of £1,565. The invested funds of the Association amount to £10,101. £2,465 was subscribed locally at the Southport meeting. The list of grants, as reported in the English journals, is as follows:

Mathematics and Physics.

Lord Rayleigh, 'Electrical Standards,' Unexpended balance.

Professor J. W. Judd, 'Seismological Observations,' £40.

Dr. W. N. Shaw, 'Upper Atmosphere Investigations,' £50 and unexpended balance.

Sir W. H. Preece, 'Magnetic Observations,' £60.

Chemistry.

Sir H. Roscoe, 'Wave-length Tables of Spectra,' £10.

Professor E. Divers, 'Study of Hydroaromatics,' £25.

Geology.

Mr. J. E. Marr, 'Erratic Blocks,' £10 and balance in hand.

Dr. R. F. Scharff, 'To Explore Irish Caves,' balance in hand.

Professor W. W. Watts, 'Movements of Underground Waters,' balance in hand.

Mr. J. E. Marr, 'Life Zones in Carboniferous Rocks,' £35.

Professor W. A. Herdman, 'Fauna and Flora of the Trias,' £10.

Mr. G. W. Lamplugh, 'To Investigate Fossiliferous Drifts,' £50.

Zoology.

Professor S. J. Hickson, 'Zoological Table at Naples,' £100.

Dr. H. Woodward, 'Index Animalium,' £60.

Professor W. F. R. Weldon, 'Investigations in Development in the Frog,' £15.

Professor S. J. Hickson, 'Researches on the Higher Crustacea,' £15.

Economic Science and Statistics.

Dr. E. Cannan, 'British and Foreign Statistics of International Trade,' £25.

Mechanical Science.

Sir J. J. Thornycroft, 'Resistance of Road Vehicles to Traction,' £90.

Anthropology.

Sir John Evans, 'Archeological and Ethnological Researches in Crete,' £100.

Dr. R. Munro, 'Researches in Glastonbury Lake Village,' £25.

Professor A. Macalister, 'Anthropometric Investigation on Egyptian Troops,' £10.

Dr. A. J. Evans, 'Excavations on Roman Sites in Britain,' £25.

Physiology.

Professor W. D. Halliburton, 'The State of Solution of Proteids,' £20.

Professor F. Gotch, 'Metabolism of Individual Tissues,' £40.

Botany.

Professor S. H. Vines, 'Completion of Monograph on Potamogeton,' £10.

Professor L. C. Miall, 'Botanical Photographs,' £5.

Professor M. Ward, 'Respiration of Plants,' £15.

Professor M. Ward, 'Experimental Studies in Heredity,' £35.

Corresponding Societies.

Mr. W. Whitaker, £20.

Making a total of £900.

The following resolutions by the committee of recommendations were agreed to:

That, as urged by the president in his address, it is desirable that scientific workers, and persons interested in science, be so organized that they may exert permanent influence on public opinion in order more effectively to carry out the third object of this association, originally laid down by the founders—namely, to obtain a more general attention to the objects of science, and a removal of any disadvantages of a public kind which impede its progress—and that the council be recommended to take steps to promote such organization.

That the council be requested to consider the desirability of urging upon the Government, by a deputation to the First Lord of the Treasury or otherwise, the importance of increased national provision being made for University education.

A resolution was also approved to the effect that the sectional committees should be continued in existence until their successors were appointed, and should be authorized to bring to the notice of the council, in the intervals between the meetings of the Association, any matters in which the action of the council might be desirable. The appointment of twenty-six committees without grants was approved.

The following resolutions presented to the committee of recommendations by section A were approved:

That the attention of the council be called to the utility which would result from obtaining more uniformity in the units adopted in meteorology and to the fact that the moment has come for bringing about such uniformity.

That the systematic investigation of the upper currents of the atmosphere by means of kites or balloons is of great importance to meteorology, and that the council be asked to take such steps as they may think fit to urge upon the treasury the importance of providing the Meteorological Council with the funds necessary for the purpose.

At a meeting of the general committee the names of Professor Simon Newcomb, of Washington, Professor L. Boltzmann, of Leipzig, and Professor Mascart, of Paris, were added to the vice-presidents of Section A. Dr. W. A. Herdman was elected one of the secretaries of the Association in the room of Dr. B. H. Scott. The Association will meet on August 17, 1904, at Cambridge, under the presidency of Mr. Arthur Balfour, the prime minister. The following year the meeting will be in South Africa, the governments of Cape Colony, Natal and other colonies having appropriated £6,000 to assist in the transportation of members.

SCIENTIFIC NOTES AND NEWS.

Dr. W. A. Noyes, of the Rose Polytechnic Institute, has accepted the position of chemist in the National Bureau of Standards. During the present year while the laboratories are in course of erection, Professor Noyes will enjoy the hospitality of the Johns Hopkins University.

Professor George H. Darwin, of Cambridge University, has been elected associate of the Belgian Academy of Sciences in the room of the late Professor Stokes.

Dr. M. P. Ravenel has been appointed assistant medical director and chief of the

laboratory of the Henry Phipps Institute for the Study and Treatment and Prevention of Tuberculosis, Philadelphia.

Dr. Andrew D. White, formerly president of Cornell University and ambassador to Germany, has decided to spend the winter in Germany and Italy. He will consequently be unable to give the lectures that had been planned at Yale and Cornell Universities.

Mr. R. S. Williams, museum aid at the New York Botanical Garden, has been sent to the Philippine Archipelago to make collections for the garden.

Dr. F. L. Tufts, tutor in physics in Columbia University, has been given a year's leave of absence to spend in research in Germany.

Dr. Eugene C. Sullivan, of the University of Michigan, and Mr. Waldemar T. Schaller, of San Francisco, have been appointed assistant chemists in the United States Geological Survey. The appointments were made upon the basis of civil service examinations.

Mr. J. C. Cadman has been elected president of the British Institution of Mining Engineers.

Professor Augustus Radcliffe-Grote, director of the Museum in Hildesheim, an authority on entomology, died on September 23. He lived for many years in New York State, being director of the Buffalo Academy of Science.

The death is announced of the Rev. Maxwell Henry Close, at Dublin on September 15, at the age of eighty-one years. He had devoted himself to scientific pursuits since 1861, having published papers on astronomical and other subjects.

The Henry Phipps Institute for the Study, Treatment and Prevention of Tuberculosis has arranged for the coming fall and winter a series of lectures on various phases of tuberculosis. The first of these lectures will be given by Dr. E. L. Trudeau, of Saranac Lake, N. Y., during the last week in October, his subject being 'The History of the Development of the Tuberculosis Work at Saranac Lake.' The following have been invited to give the subsequent lectures: Dr. Pannwitz, of Germany, in November; Dr. William Osler, of Baltimore, in December; Dr. Calmette, director of the Pasteur Institute, at Lille, France, in January; Dr. Herman M. Biggs, of New York, in February, and Dr. Maragliano of Italy, in March. All of them have accepted with the exception of Dr. Calmette, who will come if it is possible.

The American Grape Acid Association, 318 Front St., San Francisco, Cal., offers a premium of $25,000 for any person who devises a process or formula for the utilization of California grapes containing over twenty per cent. of saccharin, worth $10 a ton, to produce tartaric acid at a price that would permit of exportation without loss. The decision in awarding the amount is to rest with a jury of five, of which Professor E. W. Hilgard, of the University of California, is one. The offer closes on December 1, 1904.

A Japanese translation of 'Elements of Sanitary Engineering,' by Professor Mansfield Merriman, has recently been published at Tokio. The translator is B. Onuma, principal of the Kogyokusha Engineering College at Shiba.

A cablegram to the daily papers states that a high speed trial over the Zossen experimental electric railroad on September 26 resulted in attaining a speed at the rate of over 117 miles per hour. Every part of the 100-ton car was intact and the roadbed was not affected.

A correspondent of the London *Times* writes that students of the history and of the prehistoric times of the Scandinavian countries have been much surprised by the recent discovery of an artistically highly-finished 'sun chariot'—a structure of ancient religious and sacrificial import—in a moor of Seeland in Denmark. From the site where it was found it is supposed to be not less than 3,000 years old. It is now in the museum at Copenhagen. The subject is of great interest for the whole Scandinavian and Germanic race.

We learn from the London *Times* that it is stated that a scheme is on foot for the organization of a floating industrial exhibition of British manufactures, which is to make

a tour of the Empire. The movement has the support of prominent shipping and manufacturing firms, but it has not yet taken final shape. The plan which is now in course of development is to fit out a large ship with samples of all classes of manufactured articles which Great Britain supplies or can supply to her Colonies, including even fairly heavy machinery. From 50 to 100 firms are expected to exhibit, and a representative of each firm will accompany the ship, which, in the course of a voyage extending over some six months, will call at every port of importance in the British Colonies and dependencies, as well as in Japan, China and other specially selected places. It is the intention of the organizers to be in a position to sail in the early part of next year.

DR. R. BOWDLER SHARP writes to the editor of the *Times:* In common with many other zoologists, I have been somewhat concerned to see the avidity with which certain journals in this country publish broadcast myths connected with natural history, and the credulity with which nonsensical paragraphs of this kind are received by the public. The myth most in vogue in the springtime is the one that the British Museum is in want of a kingfisher's nest, and has offered a reward of £100 to anybody who will procure one for the national collection. This fable dies hard, and causes me much loss of time every spring in assuring well-meaning collectors that the British Museum has long ago acquired as many kingfisher's nests as it wants. On a par with this foolish myth is another which is now being exploited—viz., the story that a well-known entomologist has paid £1,000 for a specimen of a flea! The journals which print, and the folk who read, this nonsense must surely know it is untrue. The fleas and mosquitoes are both families of insects extremely difficult to study. We know the mischief which is done by mosquitoes in the case of malaria, and the report of the Plague Commission shows that fleas play no unimportant part in the dissemination of disease. To make a collection of these noxious insects is a tedious and difficult matter, but they have to be studied and monographed like butterflies and the higher orders. It is, therefore, annoying to zoologists to find mendacious statements published broadcast which are calculated to bring into ridicule the earnest work which is being carried on by entomologists who devote themselves to the study of these difficult groups. I have heard of one instance when a new and curious genus of *Pulicidæ* was valued at 10s., but, as a rule, the sum of 3d. or 6d. is considered sufficient value by museums for any specimen of fleas obtained from animals in any part of the world. There is, sir, a considerable difference between sixpence and a thousand pounds, and it may be considered that the exposure of such a palpable untruth is not worth the time that it takes to expose it; but the reiteration of the myth in responsible journals, and the credulity of the public, as shown by the correspondence on the subject, make it desirable to give publicity to the true facts of the case.

MR. W. W. HARRIS, U. S. Consul at Mannheim, writes to the Department of State: Beginning with June 7, 1903, a three days' congress of the German Society of Electricians was held in Mannheim. The meetings were attended by about 300 electrical engineers from all parts of the empire. Papers were read on a variety of topics pertaining to electrical engineering, especially as applied to street-railway construction, electric lighting, etc. Among those who presented papers were Privy Councillor Professor Arnold, of Carlsruhe; Professor Görges, of Dresden; and Baron von Gaisberg, of Hamburg. At this meeting, as at similar meetings in Germany, that which first attracts the attention of the observer is the active part taken by teachers from the technical and other schools in what might be regarded the purely practical side of the subject. Thus, in this particular case the discussions led into the construction of street railways, installation of light and power plants, etc. Among those who took a leading part in these discussions were teachers and professional men. No opinion is ventured as to whether, upon the whole, a science such as that of electricity, mining, architecture, etc., progresses more rapidly if left mainly to what

may be termed the self-made unprofessional engineers or if left more under professional or academic control. The German manufacturer or railway builder would doubtless answer the question in favor of the professionally trained expert. The conditions existing in the two countries being in many respects different, the advancement made in electrical engineering, for example, affords no complete answer to the question. It would be conceded on both sides of the ocean that in the more difficult field of chemical manufacture the professionally trained chemist has been indispensable.

The New York State Civil Service Commission will receive until October 10, applications for the positions of instructors in various manual arts in the reformatory and industrial institutions of the state. The salaries are in most cases $65 a month and board. Candidates will not be required to appear at any place for examination but will be rated on their education, special training, experience and personal qualifications as shown by their sworn statements, and by the answers to inquiries made by the Commission of their former employers and others acquainted with their experience and qualifications. Duly authenticated specimens of the work of candidates may also be required to be submitted in conformity to regulations to be prescribed by the Commission.

UNIVERSITY AND EDUCATIONAL NEWS.

The daily papers state that Mr. John Hays Hammond, professor of mining engineering at Yale University, will present to that institution a metallurgical laboratory costing from $25,000 to $50,000.

It is reported that donations amounting to $300,000 have been made to the University of Chicago, for archeological research in Egypt and Babylonia.

It is also reported that the University of Chicago has purchased the south frontage of the Midway Plaisance between Cottage Grove and Madison Avenue at a cost of $1,450,000 and that this land will be used as a medical school including the Rush Medical College and the McCormick Memorial Institute for Infectious Diseases.

The University of Illinois has acquired in connection with the College of Physicians and Surgeons the Chicago College of Dental Surgery.

A press despatch to the daily papers from Des Moines, Ia., states that Mr. Frederick M. Hubbell, has conveyed, jointly with his wife, property to the value of about $5,000,000 to himself and his sons, Frederick C. Hubbell and Grover C. Hubbell of Des Moines, trustees of the said Frederick M. Hubbell estate, and to their successors in trust for the trustees and their lineal descendants, to the State of Iowa, to be used in founding a college in Des Moines. The trust period begins with the date of the declaration, and continues to the limit of time allowed by the law, viz., for a life or lives in being and twenty-one years thereafter.

The chemical laboratory at Brown University has been made about one-third larger during the summer.

Dr. T. H. Montgomery, Jr., assistant professor of zoology at the University of Pennsylvania, has been appointed to the professorship of zoology in the University of Texas, vacant by the removal of Professor W. M. Wheeler to the American Museum of Natural History. Dr. Herbert S. Jennings, assistant professor of zoology at the University of Michigan, and now at Naples, has been called to the assistant professorship of zoology at the University of Pennsylvania.

Dr. E. R. Cummings, Ph.D. (Yale), has been promoted to the position of acting head of the Department of Geology at Indiana University.

Dr. Edward R. Posner has been appointed assistant in physiological chemistry, Columbia University.

Dr. Karl Diener has been appointed associate professor of paleontology in the University of Vienna.

Dr. A. Hansgirg, professor of botany at Prague, has retired after forty years of service.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 9, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ADDRESS TO THE GEOLOGICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.*

THERE are two circumstances which invest the fact of my presidency of the section this year with peculiar pleasure to myself. The first public lecture I ever gave was in the Town Hall at Birkdale in 1882, and the first of the fifteen meetings of the British Association which I have attended was that held in Southport in 1883.

There is still a third reason that this meeting is in many respects a geological meeting. A paleobotanist is presiding over Section K, and the council has invited, for the first time for many years, one geologist to deliver an evening discourse and another to give the address to artisans. I need hardly say that we are all looking forward to the lectures of Dr. Rowe and Dr. Flett with keen anticipation. To the one for his successful use of new methods of developing fossils and his scientific employment of the material thus prepared in stratigraphic research; to the other for his prompt, daring and business-like expedition to the scene of recent volcanic activity in the West Indies, during which he and his colleague, Dr. Tempest Anderson, collected so many important facts and brought away so much new knowledge of the mechanism of that disastrous and exceptional volcanic outbreak.

* Southport meeting, 1903.

THE FUNCTIONS OF GEOLOGY IN EDUCATION AND IN PRACTICAL LIFE.

At the meeting in 1890, at Leeds, my old friend Professor A. H. Green delivered an address to the section which has generally been regarded as expressing an opinion adverse to the use of the science of geology as an educational agent. Some of the expressions used by him, if taken alone, certainly seem to bear out this interpretation. For instance, he says: 'Geologists are in danger of becoming loose reasoners'; further he says: 'I can not shut my eyes to the fact that when geology is to be used as a means of education there are certain attendant risks that need to be carefully and watchfully guarded against.' Then he adds: 'Inferences based on such incomplete and shaky foundations must necessarily be largely hypothetical.'

Such expressions, falling from an accomplished mathematician and one who was such an eminent field geologist as Professor Green, the author of some of the most trustworthy and most useful of the Geological Survey 'Memoirs,' and above all one of the clearest of our teachers and the writer of the best and most eminently practical text-book on physical geology in this or any other language, naturally exercised great influence on contemporary thought. And I should be as unwise as I am certainly rash in endeavoring to controvert them but for the fact that I think he only half believed his own words. He remarks that "to be forewarned is a proverbial safeguard, and those who are alive to a danger will cast about for a means of guarding against it. And there are many ways of neutralizing whatever there may be potentially harmful in the use of geology for educational ends."

After thus himself answering what is in reality his main indictment, Professor Green proceeds with the rest of an address crammed full of such valuable hints as could only fall from an experienced and practical teacher, showing how much could be done if the science were only properly taught.

And then he concludes by asking for 'that kindly and genial criticism with which the brotherhood of the hammer are wont to welcome attempts to strengthen the corner-stones and widen the domain of the science we love so well.'

I think the time has now come to speak with greater confidence, and, although the distance signal stands at danger, to forge ahead slowly but surely, keeping our eyes open for all the risks of the road, with one hand on the brakes and the other on the driving gear, secure at least in the confidence that nature, unlike man, never switches a down train on to the up track.

Those of us who have been teaching our science for any considerable time have come to realize that there are many reasons why geology should be more widely taught than at present; that there are many types of mind to whom this science appeals as no other one does; and that there are abundant places and frequent circumstances which allow of the teaching of it when other sciences are unsuitable.

To begin with, there is no science in which the materials for elementary teaching are so common, so cheap and everywhere so accessible. Nor is there any science which touches so quickly the earliest and most elementary interests. It was for this reason that Huxley built his new science of physiography on a geological basis. Hills, plains, valleys, crags, quarries, cuttings, are attractive to every boy and girl, and always rouse intelligent curiosity and frequent inquiry; and although the questions asked are difficult to answer in full, a keen teacher can soon set his children to hunt for fossils or structures which will

give them part of the information they seek. Of course the teaching can not go very far without simple laboratory and museum accommodation, and without a small expenditure on maps and sections; but the former of these requirements can soon be supplied from the chemical laboratory and by the collection of the students themselves, while the latter are every day becoming cheaper and more accessible and useful. The bicycle and the camera, too, are providing new teaching material and methods, while at the same time they are giving new interests. The bicycle has already begun to create a generation to whom relief maps are not an altogether sealed book, and for whom the laws which govern the relief of a country are rapidly finding practical utility; and the camera, at the same time that it quickens the appreciation of natural beauty, must give new interest to each scrap of knowledge as to the causes, whether botanical or geological, to which that beauty is due. And it is this new knowledge which in turn develops the æsthetic sense. *Mente, manu et malleo* sums up most of what is required in the early stages of learning; but to round off the motto we still require words to express the camera and bicycle.

Another reason is the open-airness of the practice of the science. The delight of the open country comes with intense relief after the class-room, the laboratory or the workshop. In education generally, and especially in geological education, we have reached the end of the period when

> 'all roads lead to Rome
> Or books—the refuge of the destitute.'

Of course I realize fully the vital necessity of laboratory and museum work in the stages of both learning and investigation, and quite freely admit that there is an immense amount of useful work being done and to be done in these institutions alone. But what I think I do right to insist upon is that all work in the laboratory and museum must be mainly preparatory to the field-work which is to follow; every type of geological student must be sent into the field sooner or later, and in most cases the sooner the better. I have generally found that students in the early stages have a great repugnance to the grind of working through countless varieties of minerals, rocks and fossils; but once they have gone into the field, collected with their own hands, and seen the importance of these things, and the inferences to be drawn from them, for themselves—once indeed they have got keen—they come back willingly, even eagerly, to any amount of hard indoor work.

But it is when they leave ordinary excursion work and start upon regular field training that one really feels them spurt forward. As soon as they begin to realize that surface-features are only the reflex of rock-structure and can be utilized for mapping, that to check their lines and initiate new ones they must search for and find new exposures, and that each observation while settling perhaps one disputed point may originate a host of new ones, when above all they can be trusted with a certain amount of individual responsibility and given a definite point to settle for themselves, it is then that their progress is most rapid, and is bounded only by their powers of endurance.

I have often watched my students through the various stages of their field training with the deepest interest as a study of the development of character. At first they look upon it merely as a relief from the tedium of the class-room and laboratory, and as a pleasant country excursion. But gradually the fascination of research comes over them, and as they feel their capacity increasing and their grip and in-

sight into the structure of the country deepening, one can see them growing up under one's eyes. They come into the field a rabble of larky boys; they begin to develop into men before they leave it.

And what is true of students is more than ever true of the working geologist. I hold that every geologist, whatever his special branch may be, should spend a portion of every year in the field. Though a petrologist may have specimens sent to him from every variety, even the common ones, in a rock mass and have their relations and proportions properly explained to him, it is quite impossible for him to feel and appreciate these proportions and relationships so well as if he had studied and collected in the field and gained a personal interest in them. Besides this the conclusions drawn in the field are the crystalline and washed residuum, so to speak, left on the mind after the handling of dozens of specimens, weathered and unweathered, and the seeing them in a host of different lights and aspects. The rock is hammered and puzzled over and its relations studied until some conclusion is arrived at which bears the test of application to all the facts observed in the field.

Again, once a paleontologist is divorced from the field he loses the significance of minute time variations, the proportion of aberrant to normal forms, and the value of naked-eye characteristics which can be 'spotted' in the field. Huxley once asked for a paleontologist who was no geologist; I venture to think we have now had enough of them. What we want above all at the present time is the recognition of such characters as have enabled our field paleontologists to zone by means of the graptolites, the ammonites and the echinids, so that every rock system we possess may be subdivided with the same minuteness and reliability as the Ordovician, Silurian and Jurassic systems and the Chalk.

If this is once done the biological results will take care of themselves, and we may feel perfect confidence that new laws of biological succession and evolution will result from such work, as indeed they are now doing—laws which could never be reached from first principles, but could only come out in the hands of those to whom time and place were the factors by which they were most impressed. It is only by field work that we shall ever get rid of the confusion which has been inevitable from the supposed existence of such so-called species as *Orthis caligramma*, *Atrypa reticularis* and *Productus giganteus*.

As for the geological result, it is only necessary to read the excellent and workman-like address delivered to this section at Liverpool in 1896 by Mr. Marr to realize how many problems of succession and structure, of distribution and causation, of ancient geography and modern landscape, are still awaiting solution by the application of minute and exact zonal researches.

On the other hand it goes without saying that the more a field geologist knows of his rocks and fossils the better will his stratigraphical work become; but this is too obvious to require more than stating.

Geology, again, is of value as a recreative science, one which can be enjoyed when cycling, walking or climbing, even when sailing or traveling by rail. Indeed, it is difficult to find a place in which to treat the confirmed geologist if you wish to make him a 'total abstainer.' There are others than those who must make use of their science in their professions, those in need of a hobby, those interested in natural scenery, veterans who have seen much and now have leisure and means to see more, and those fortunate ones who have not to

earn their bread by the sweat of their brain or brow. Many of these have done and are doing good work for us, and many more would find real pleasure in doing so if only they had been inoculated in those early days when impressions sink deep. Mr. A. S. Reid, who has had much and fruitful experience in teaching, tells me that he has often seen seed planted in barren ground at school spring up and grow and blossom as a country-holiday recreation after school days, or bear the good fruit of solid research after lying dormant for many years.

We may next look upon geology as an educational medium from quite a different point of view. If more than half the work of the man of science is the collection of fact, and of actual fact as opposed to the result of the personal equation, geology is perhaps the very best training-ground. There are such hosts of facts to be still recorded, so many erroneous observations to be corrected, and so much hope of extending observations on already recorded facts, that there is plenty of work even for the man who can snatch but limited leisure from other pursuits and the one who is a collector of fact and nothing else, as well as those

> 'under whose command
> Is earth and earth's, and in their hand
> Is Nature like an open book.'

But in the collection of facts a wise and careful selection is constantly necessary in order to pick out from the multitude those which are of exceptional value and importance in the construction of hypotheses. Nature, it is true, can not lie; she is a perfectly honest but expert witness, and it takes an astonishing amount of acute cross-examination to elicit the truth, the whole truth and nothing but the truth.

There is no science which needs such a variety of observations as field geology. When we remember that Sedgwick and Darwin visited Cwm Glas and carried away no recollection of the features which now shout 'glaciation' to every one who enters the Cwm, it is easy to see how alert must be the eyes and how agile the mind of the man who has to carry a dozen problems in his mind at once, and must be on the lookout for evidence with regard to all of them if he would work out the structure of a difficult country; and who is not only looking out for facts to test his own hypothesis, but wishes to observe so accurately that if his hypothesis gives way even at the eleventh hour his facts are ready to suggest and test its successor. There is no class of men so well up in what may be called observational natural history generally as the practiced field geologist, because he never knows at what moment some chance observation—a mound, a spring, a flower, a feature, even a rabbit-hole or a shadow—may be of service to him. Not only should he know his country in its every feature and every aspect, but he must have, and in most cases soon acquires, that remarkable instinct, which can only be denoted as an 'eye for a country,' with which generally goes a naturalist's knowledge of its plants and of its birds, beasts and fishes.

At the present time many educationists are in favor of teaching only the experimental sciences to the exclusion of those which collect their facts by observation. This attitude may do some good to geology in compelling us to pay more attention to that side of our science which has been better cultivated hitherto in France than in our own country. But whether we think of education as the equipping of a scientific man for his future career or as the training of the mind to encounter the problems of life, we must admit that it would be as wrong to ignore one of the two ways only of collecting fact as it would be to teach deductive reasoning to the exclusion

of that by induction. Indeed, this is understating the case, for in the vast majority of the problems which confront us in everyday life the solution can only be reached if an accurate grasp of the facts can be obtained from observation. The training of the mind solely by means of experiments carefully designed to eliminate all confusing and collateral elements savors too much of 'milk for babes' and too little of 'strong meat for men.'

Mr. Teall in his masterly address to the Geological Society in 1901 pointed out 'that the state of advancement of a science must be measured, not by the number of facts collected, but by the number of facts *coordinated.*' Theory, consistent, comprehensive, tested, verified, is the life-blood of our science as of any other. It is what history is to politics, what morals are to manners, and what faith is to religion.

It is almost impossible to collect facts at all without carrying a working hypothesis to string them on. It is easy to follow Darwin's advice and speculate freely; the speculation may be right, and if wrong it will be weeded out by new facts and criticism, while the speculative instinct will suggest others. In hypothesis there will always be an ultimate survival of the fittest.

And it is not only easy but absolutely necessary, because in geology, more perhaps than in any other science, hypotheses are like steps in a staircase: each one must be mounted before the next one can be reached; and if you have no intention of coming back again that way, it does not matter if you destroy each step when you have made use of it. Every new hypothesis has something fresh to teach, and nearly all have some element of untruth to be ultimately eliminated. But each one is a stage, and a necessary stage, in progress.

In physics and in chemistry the chief difficulties are those which surround the making of experiments. When these have been successfully overcome the right theory follows naturally, and verification is not usually a very lengthy process. In geology, on the other hand, theory is more quickly arrived at from the numerous facts; but the price is paid in the patience required for testing and the ruthless refusal to strain fact to fit theory. Every hypothesis leads back to facts again and again for verification, extension and improvement.

Many of the leading conclusions of our science have not yet become part of the common stock of the knowledge of the world; indeed they are not even fully realized by many men eminent in their own sciences. The momentum given by Werner and Playfair, Phillips and Jukes, Sedgwick and Lyell, and other pioneers of the fighting science, has died down, and in the interval of hard work, detailed observation, minute subdivision, involved classification and pedantic nomenclature which has followed, and which I believe to be only the prelude to an epoch of more important generalization in the immediate future, it has been difficult for an outsider to see the wood for the trees. He has hardly yet realized that facts as vital to the social and economic well-being of the people at large and conclusions of as great importance in the progress of the science and of as far-reaching consequence in the allied sciences, are being wrung from nature now as in the past.

'The unimaginable touch of time,' the antiquity of the globe as the abode of life, the absolute proof of the evolution of life given by fossils, the proofs of change and evolution in geography and climate, the antiquity of man, the nature of the earth's interior, the tremendous cumulative effect of small causes, the definite position of deposits of economic value, the role played by denudation and earth-movement in the

development of landscape, the view of the earth as a living organism with the heyday of its youth, its maturity and its future old age and death, to mention but a few of our great principles, furnish us with conceptions which can not fail to quicken the attention and inspire the thought of students of history, geography and other sciences.

Now that these things are capable of definite proof, that they are of real significance in the cognate sciences and of actual economic value, above all now that the nineteenth century, the geological century, has closed, that the heroic age is over, that we have passed the stages of scepticism and religious intolerance and reached the stage 'when everybody knew it before,' it might be expected that a fairly accurate knowledge and appreciation of these principles should form part of the common stock of knowledge, and be a starting-point in the teaching of allied sciences.

Another feature which adds to the attractiveness of geological observations is their immediate usefulness from many points of view. The relief and outline of any area is as closely related to its rocky framework as the form of a human being is related to his skeleton and muscles. The geological surveyor recognizes how every rise and fall is the direct reflex of some corresponding difference in the underlying rocks; he seeks to observe and explain the ordinary as well as anomalous ground-features, every one of which conveys some meaning to him.

A geological basis for the classification and grouping of surface-features is the only one which is likely to be satisfactory in the end, because it is the only one founded on a definite natural principle, the relation of cause to effect. It is not without good reason that the topographic and geological surveys of the United States are combined under one management, and nowhere else are the topographic results more accurate and satisfactory. Landscape is traced back to its ultimate source, and consequently sketched in with more feeling for the country and greater accuracy of knowledge than would otherwise be possible. Geologists were among the first to cry out for increasing accuracy and detail in our government maps, and they have consistently made the utmost use of the best of these maps as fast as they appeared. With the publication of each type of map, hachured, contoured, six-inch, twenty-five-inch, the value and accuracy of geological mapping has advanced step by step. Wherever the topography is better delineated than usual, the facilities are greater for accurate geological work, and the best geological maps, and those in greatest demand, are always those based on the most minute and detailed topographic work. On the other hand geologists are training up a class of men who can read and interpret the inner meaning of these maps, and make the fullest use of the splendid facilities given by the minute accuracy of the ordnance work.

Lord Roberts has recently complained that the cadets at Woolwich are unable to read and interpret maps, and he 'strongly advised them to set about improving themselves in this respect, or they would find themselves heavily handicapped in the future.' I believe that the only training in this subject before entering the Royal Military Academy and the Royal Military College has been that given to those candidates who have taken up geology for their entrance examination. By encouraging these students to study and draw maps and sections of their own districts, and to explain and draw sections across geological maps generally, thus accounting for surface-features, the examiners have com-

pelled this small group of candidates to see deeper into a map than ordinary people. If only this training had been encouraged and advanced and made use of later, the commander-in-chief would have had no cause of complaint with regard to these particular men. Looking at a map is one thing; working at it, seeing into it and getting out of it what is wanted from the vast mass of information crammed into it, is quite another; and geology is the very best and perhaps the only means of compelling such a close study of maps as to enable students to seize upon the salient features of a country from a map as quickly and accurately as if the country itself were spread out before them. The geologist is compelled to work out and classify for himself the features he observes on his maps, such as scarps and terraces, crags and waterfalls, streams and gorges, passes and ridges, the run of the roads, canals and railways, the nature and accessibility of the coast, and all those features which make the difference between easy-going and difficult country. When he has worked his way over a map in this fashion that map becomes to him a real and telling picture of the country itself.

Experience, bitter experience, in South Africa has shown the necessity not only for good maps and map-reading, but for that which is the most priceless possession alike of the best field geologists and of the best strategists, a good 'eye for a country.' It has been said that the Boer war was a geographical war; but it was even more, and, especially in its later stages, a topographic war. Again and again the Boers aroused our astonishment and admiration by the way in which their topographic knowledge and instinct enabled them to fight, to defend themselves and to secure their retreat by the most consummate ability in utilizing the natural features of their country. This was due to two things. In the first place they took care to have with them in each part of the country the men who knew that particular district best in every detail and in every aspect. But in the second place there can be no doubt that they made the utmost use of that hunter-craft by which the majority of them could take in at a glance the character of a country, even a new one, as a whole, guided by certain unconscious principles which each man absorbed as part of his country life and hunter's training. They possessed, and had of necessity cultivated to a very high degree, an 'eye for a country.'

Now the study of the geology of any district, and especially the geological mapping of it, goes a long way towards giving and educating the very kind of eye for a country which is required, partly by reason of the practice in observation and interpretation which it is continuously giving, and partly because it deliberately supplies the very kinds of classification and the principles of form which a hunter-people have unconsciously built up from their outdoor experience.

Any geologist who thinks of the Weald, the wolds and downs of eastern England, the scarps and terraces of the Pennine, the buried mountain structure of the Midlands, even the complicated mountain types of Lakeland and Wales, will remember how often his general knowledge of the rock structure of the region has helped him as a guide to the topography; and as his geological knowledge of the area has increased he will recall how easy it has become to carry the most complicated topography in his mind, or to revive his recollection of it from a glance at the map, because the geological structure, the anatomy, is present in his mind throughout; and the outside form is the inevitable con-

sequence of that structure. Indeed the reading of a good geological map to the geologist is like the reading of a score by a musician.

Surely it would be most unwise if the Committee on Military Education were to cut out of their curriculum the one subject which has exercised and educated this faculty, and one which is at the same time doing a great deal to counteract that degeneration of observing faculties inseparable from a town life. Some cadets at least ought to be chosen from amongst those men who have been trained by this method to see quickly and accurately into the topographic character and possibilities of a country, and provision should be made for educating their faculties further until they become of genuine strategic value.

Then I believe it would be correct to say that no class of men get to know their own country with anything like the minuteness and accuracy of the geological surveyor. The mere topographer simply transfers his impressions on the spot as quickly as may be to paper, and has no further concern with them. The geologist must keep them stored in his mind, watching the variation and development of each feature from point to point for his own purposes. He must traverse every inch of his ground, he must know where he can climb each mountain and ford every brook, where there are quarries or roads, springs or flats; what can be seen from every point of view, how the habitability or habitations vary from point to point; in short, he must become a veritable walking map of his own district. Why not scatter such men in every quarter of the globe, particularly where any trouble is likely to arise? They are cheap enough, they will waste no time, and they will be so glad of the chance for research that they will not be hard to satisfy in the matter of pay and equipment. Thus you will acquire a corps of guides, ready wherever and whenever they are wanted; and when trouble arises they may do a great deal by means of their minute knowledge of topography to save millions of money and thousands of lives, and to prevent the irritating recurrence of the kind of disaster with which we have become sadly familiar within the last five years.

In dealing with the relationship of geology to geography geologists are frequently charged with claiming too much. On this point at least, however, there can be no difference of opinion, that the majority of geological surveyors and unofficial investigators have kept their eyes open to this relationship, and have often contributed new explanations to old problems. They have been compelled to observe, and often to explain, surface features before making use of them in their own mapping, and in doing so have often hit upon new principles. It is hardly needful to mention such examples as Ramsay's great conception of plains of marine denudation, Whitaker's convincing memoir on subaerial denudation, Jukes's explanation of the laws of river adjustment, Gilbert's scientific essay on erosion, Heim's demonstration of the share taken by earth movement in the modeling of landscape features, and the exceedingly valuable proofs of the relation of human settlement and movement to underground structure, worked out with such skill and diligence by Topley in his masterly memoir on the Weald—the jumping-off place, if I may so term it, of the new geography.

No one is more pleased than geologists that geographers have ceased to draw their knowledge of causation solely from history, and that they have turned their attention to the dependence and reaction of mankind on nature as well. But while hoping

that geographers will continue to study, so far as they logically can, the relationship of plants, animals and mankind to the solid framework of the globe on which they live, we must draw the line at the invention of new geological hypotheses to explain geographic difficulties on no better evidence than that furnished by the difficulties themselves; on the other hand, we must insist that each new geological principle must take its place amongst geographic explanations as soon as it is freely admitted to be based on a sound substratum of fact.

I must confine myself to a few instances of what I mean. Mr. Marr's geological work on the origin of lake basins has led to some remarkable and unexpected conclusions with regard to the history and origin of the drainage of the lake district. Some of the very difficult questions raised by the physical geography of the North Riding of Yorkshire have received a new explanation from the researches of Professor Kendall and Mr. Dwerryhouse, an explanation which is the outcome of purely geological methods of observation of geological materials. Again, the simple geological interpretation of a well-known unconformity between Archæan and Triassic rocks has made it extremely probable that many of the present landscapes, not only in the Midlands but elsewhere, may be really fossil landscapes, of great antiquity and due to causes quite different from those in operation there at the present day. In mountain regions, too, it can only be by geological observation that we shall ever determine what has been the precise direct share of earth movement in the production of surface relief. Such examples seem to indicate that many of the principles must be of geological origin but of geographic application.

While geology has been of direct scientific utility in topography and geography, there is another domain, that of economic geology, which is entirely its own. The application of geology extends to every industry and occupation which has to do with our connection with the earth on which we live. Agriculture, engineering, the obtaining of the useful and precious metals, chemical substances, building materials, and road metals, sanitary science, the winning and working of coal, iron, oil, gas and water, all these and many more pursuits, are carried on the better if founded on a knowledge of the structure of the earth's crust. Indeed a geological map of this country, showing rocks, solid and superficial, of which no economic use could be made, would be nearly blank. Yet so much has this side of the science been neglected of recent years that our only comprehensive text-books on it are altogether out of date.

But in teaching geology as a technical science, or rather as one with technological applications, one of the greatest difficulties before us is to steer between two opposing schools, the so-called theoretical school and the practical school.

There are those who say that there is but one geology, the theoretical, and that a thorough knowledge of this must be obtained by all those who intend to apply the science. Others think that this is too much to ask—that the time available is not sufficient—and that it is only necessary to teach so much of the subject as is obviously germane to the question in hand.

The best course appears to me to be the middle one between the two extremes. If the engineer or miner, the water-finder or quarryman, has no knowledge of principles, but only of such facts as appear to be required in the present position of his profession, he will be incapable of making any improvement in his methods so far as they

depend upon geology. If, on the other hand, he is a purely theoretical man without a detailed practical and working acquaintance with the facts which specially concern him, he will be put down by his colleagues as unpractical; he will have to learn the facts as quickly as he can and buy his experience in the dearest market.

It seems to me that there is certain common ground which must be acquired by all types of professional men. The general petrographic character of the common rocks, enough of their mode of origin to aid the memory, the principle of order and age in the stratified rocks, the use of fossils and superposition as tests of age, the nature of unconformities, the relation of structure to the form of the ground, the occurrence of folds and faults, and above all the reading of maps and sections, and sufficient field work to give confidence in the representation of facts on maps—these things are required by everybody who makes any use of geology in his daily life.

But when so much has been acquired it should be possible to separate out the students for more special treatment. The coal-miner will require especially a full knowledge of the coal-bearing systems, not in our own islands merely, but all over the world; a special acquaintance with the effects of folds and faults, and an advanced training in the maps and sections of coal-bearing areas. The vein-miner should be well up in faulting and all the geometrical problems associated with it, and he should have an exhaustive acquaintance with the vein and metalliferous minerals.

The water engineer needs to know especially well the porous and impervious rock types, the texture and composition of these rocks, the nature of their cements and joints, and the distribution of water levels in them. Further, he must know what there is to be done on the problems of permeability and absorption; the relation of rain to supply, the changes undergone by water and the paths taken by it on its route underground, and the varying nature of rocks in depth. He must also realize the effects of folds and faults on drainage areas and on underground water courses, the special qualities of water-yielding rocks, of those forming the foundation of reservoir sites, and those suitable for the construction of dams.

The sanitary engineer will need to be acquainted with the same range of special knowledge as the water engineer, but will naturally be more interested in getting rid of surface water without contaminating it more than he can help than in obtaining it; he will also need a more detailed acquaintance with superficial deposits than any other class of professional men.

The quarryman and architect ought to know the rocks both macroscopically and microscopically, in their chemical and mineralogical character, their grains and their cements. But he ought to be well acquainted with the laws of bedding, jointing and cleavage, with questions of outcrop and underground extent, and all those other characters which make the difference between good and bad stone, or between one desirable and undesirable in the particular circumstances in which a building is to be erected. Further, he should make a particular study of the action of weight and weather on the rocks which he employs.

The road engineer and surveyor, now that it has been discovered that it is cheaper and better to use the best and most lasting road metal instead of any that happens to be at hand, requires to have an extensive acquaintance with our igneous and other durable rocks. He needs, however, not only petrographic and chemical knowledge, but also a type of information

not at present accessible in England, the relative value of these rocks in resisting the wear and tear of traffic, the cementing power of the worn material, and the surface characters of roads made from them, in order that he may in each case select the stone which in his particular circumstances gives the best value for money. It would surely pay the county councils to follow, with modifications, the example of the French and Americans, and carry out a deliberate and well-planned series of experiments on all the material accessible to them in their respective districts.

The teaching of the application of geology should, therefore, take some such form as the following: First, the principles should be thoroughly taught with the use for the most part of examples drawn from the economic side; thus cementing might be illustrated on the side of water percolation, jointing from the making of mine roads and from quarry sites, faulting from effects on coal outcrops and veins, unconformity from its significance to the coal-miner; while in teaching the sequence of stratified rocks the systems and stages could be mainly individualized by their economic characters. When this is done the class must be divided into groups, each paying special attention to the points which are of essential importance to them.

The teaching at all stages should be practical and, so far as can be, experimental, and in all cases where possible a certain amount of field work should be attempted. For the field after all is the laboratory of the geologist where he can observe experiments being made on a gigantic scale under his eyes.

The aim of the teaching should be to give to students the equipment necessary to deal with the chief geological problems that they will meet with in their varied professions; it should show them where to go for maps, memoirs or descriptions of the areas with which they are dealing; and in cases of great difficulty should enable them to see where further geological assistance is required, and to weigh and balance the expert evidence given them against the economic and other factors of the problem before them.

From men educated thus geology has the right to expect a valuable return. There is a vast amount of knowledge on economic subjects in existence but not readily accessible. It has been obtained by experts, and after being used is locked up or lost. And yet it is the very kind of knowledge which is wanted to extend our principles further into the economic side of the subject. So well is this recognized that many geologists are attracted to economic work mainly because of the wide range of new facts that they can only thus become acquainted with. It is possible to make use of many of these facts for scientific induction without in any way betraying confidence or revealing the source from which they are obtained; and even if they can not be used directly they are often of great service in giving moral support, or the contrary, to working hypotheses founded on other evidence.

The knowledge of our mineral resources is of such vital consequence to ourselves and to our present and future welfare as a nation, and yet it is a matter of so much popular misconception, that I feel bound to dwell on this subject a little longer. To any one who studies the growth and distribution of population in any important modern state the facts and reasons become as clear as day.

It is easy to construct maps showing at a glance the density of population in any country. Perhaps the most effective way to do so is to draw a series of isodemic lines and gradually to increase the depth

of tint within them as the number of people per square mile increases, until absolute blackness represents, say, over 2,000 people per square mile. Such maps are the best means of displaying the geography of the available sources of energy in a country at any particular period. Population maps of England and Wales in the early part of the eighteenth century would be pale in tint with a few rather darker patches, and would show a distribution dependent solely upon food as a source of energy working through the medium of mankind and animals. Such maps would be purely agricultural and maricultural, dependent upon the harvests of the land and sea. Maps made at a later period would show a new concentration around other sources of energy, particularly wind and water, but would not be perceptibly darker in tint as a whole; for although we are apt to think that we have in this country too much wind and water, they are not in such a form that we can extract any appreciable supply of energy directly from them.

But maps representing the present population, while still mainly energy maps, at once bring out the fact that our leading source of energy is now *coal* and no longer food, wind or water. The new concentrations, marked now by patches and bands of deepest black, have shifted away from the agricultural regions and settled upon and around the coal fields. The map has now become geological.

The difference between the old and the new map is, however, not only in kind; it is even more remarkable in degree. The population is everywhere much denser. Not only are the mining and manufacturing areas on the new map more than eight times as densely populated as any areas on the older map, not only is the average population five times greater throughout the country, but the lightest spot in the new map is nearly as dark as the darkest spot on the old one. The sparsest population at the present day is as thick on the ground as it was in the densest spots indicated on the older map, while at the same time the standards of wages, living and comfort, instead of decreasing, have increased.

The discovery of this new source of energy, coal, immediately gave employment to a much larger number of people; it paid for their food and provided the means of transporting it from the uttermost parts of the earth. Under agricultural conditions the map shows that the population attained a given maximum density, and no further increase was possible, the density being regulated by the food supply raised on the surface of the land. Our dwelling-house was but one story high. Under industrial conditions our mineral resources can support five times the number. Our dwelling-house is of five stories —one above ground and four below it.

At the same time the type of distribution is altered. The agricultural areas are now covered by a relatively scanty population, and the dense areas are situated on or near to the coal and iron fields, the regions yielding other metals, those suitable for industries which consume large supplies of fuel, and a host of new distributing centers, nodal points on the new line of traffic, either inside the country or on its margins where the great routes of ocean transport converge, or where the sea penetrates far in towards the industrial regions.

It has been the good fortune of this country to be the first to realize, and with characteristic energy to take advantage of, the new possibilities for development opened up by the discovery and utilization of its mineral wealth. We were exceedingly fortunate in having so much of this wealth at hand, easy to get and work from

geological considerations, cheap to transport and export from geographical considerations. So we were able to pay cash for the products of the whole world, to handle, manufacture and transport them, and thus to become the traders and carriers of the world.

But other nations are waking up. We have no monopoly of underground wealth, and day by day we are feeling the competition of their awakening strength. Can we carry on the struggle and maintain the lead we have gained?

In answering this question there are three great considerations to keep in mind. First, our own mineral wealth is unexhausted; secondly, that of our colonies is as yet almost untouched; and thirdly, there are still many uncolonized areas left in the world.

The very plenty of our coal and iron, and the ease of extracting it, has been an economic danger. There has been waste in exploration because of ignorance of the structure and position of the coal-yielding rocks; waste in extraction because of defective appliances, of the working only of the best-paying seams and areas, of the water difficulty, and the want of well-kept plans and records of areas worked and unworked; waste in employment because of the low efficiency of the machinery which turns this energy into work. With all this waste our coal fields have hardly yielded a miserable *one* per cent. of the energy which the coal actually possesses when *in situ*.

Engineers and miners are trying to diminish two of these sources of waste, and geology has done something to reduce that of exploration. This has been done by detailed mapping and study, so that we now know the areas covered by the coal-seams, their varying thickness, the 'wants,' folds and faults by which they are traversed, and all that great group of characters designated as the geological structure of the coal fields. It could not have been accomplished unless unproductive as well as productive areas had been studied, the margins of the fields mapped as well as their interiors, and unless the geological principles wrested from all sorts of rocks and regions had been available for application to the coal districts in question. We no longer imagine every gray shale to be an index of coal; we are not frightened by every roll or fault we meet with underground; nor do we, as in the past, throw away vast sums of money in sinking for coal in Cambrian or Silurian rocks.

We can not afford, hard bitten as we are in the rough school of experience and with our increased knowledge, to make all the old mistakes over again, and yet we are on the very eve of doing it. Up to the present it is our visible coal fields that we have been working, and we have got to know their extent and character fairly well. But so much coal has now been raised, so much wasted in extraction, and so many areas rendered dangerous or impossible to work, that we can not shut our eyes to the grave fact that these visible fields are rapidly approaching exhaustion. The government has done well to take stock again of our coal supply and to make a really serious attempt by means of a royal commission to gauge its extent and duration; and we all look forward to that commission to direct attention to this serious waste and to the possibility of better economy which will result from the fuller application of scientific method to exploration, working and employment.

But we still have an area of concealed coal fields left, possibly at least as large and productive as those already explored and as full of hope for increased industrial development. It is to these we must now turn attention with a view of obtaining

from them the maximum amount possible of the energy that they contain. The same problems which beset the earlier explorers of the visible coal fields will again be present with us in our new task, and there will be in addition a host of new ones, even more difficult and costly, to solve. In spite of this the task will have to be undertaken, and we must not rest until we have as good a knowledge of the concealed coal fields as we have of those at the surface. This knowledge will have to be obtained in the old way by geological surveying and mapping and by the coordination of all the observations available in the productive rocks themselves and in those associated with them, whether made in the course of geological study or in mining and exploration. But now the work will have to be done at a depth of thousands instead of hundreds of feet, and under a thick cover of newer strata resting unconformably on those we wish to pierce and work. When we get under the unconformable cover we meet the same geology and the same laws of stratigraphy and structure as in more superficial deposits, but accurate induction is rendered increasingly difficult by the paucity of exposures and the small number of facts available owing to the great expense of deep boring. How precious, then, becomes every scrap of information obtained from sinkings and borings, not only where success is met with, but where it is not; and how little short of criminal is it that there should be the probability that much of this information is being and will be irretrievably lost!

Mr. Harmer pointed out in a paper to this section in 1895 that under present conditions there was an automatic check on all explorations of this kind. The only person who can carry it out is the land-owner. If he fails he loses his money and does not even secure the sympathy of his neighbors. If he succeeds his neighbors stand to gain as much as he does without sharing in the expense. The successful explorer naturally conceals the information he has acquired, because he has had to pay so heavily for it that he can not afford to put his neighbors in as good a position as himself and make them his rivals as well; while the unsuccessful man is only too glad to forget as soon as possible all about his unfortunate venture. And yet in work of this kind failure is second only to success in the value of the information it gives as to the underground structure which it is so necessary to have if deep mining is to become a real addition to the resources of the country.

Systematic and detailed exploration, guided by scientific principles, and advancing from the known to the unknown, ought to be our next move forward: a method of exploration which shall benefit the nation as well as the individual, a careful record of everything done, a body of men who shall interpret and map the facts as they are required and draw conclusions with regard to structure and position from them—in short, a geological survey which shall do as much for hypogean geology as existing surveys have done for epigean geology is now our crying need. Unless something of this sort is done, and done in a systematic and masterful manner, we run a great risk of frittering away the most important of our national resources left to us, of destroying confidence, of wasting time and money at a most precious and critical period of our history, and of slipping down-hill at a time when our equipment and resources are ready to enable us to stride forward.

We do not want to be in the position of a certain town council which kept a list of its old workmen and entered opposite one, formerly sewerage inspector, that he pos-

sessed 'an extensive memory which is at the disposal of the corporation.'

Even supposing the scheme outlined by Mr. Harmer can not be carried out in its complete form, a great deal will be done if mining engineers can receive a sufficient geological training to enable them to realize the significance of these underground problems, so that they can recognize when any exploration they are carrying out inside their own area is likely to be of far-reaching geological and economic significance outside the immediate district in which they are personally and immediately concerned.

Turning to our colonies it is true that in many of them much is being done by competent surveys to attain a knowledge of mineral resources, but this work should be pushed forward more rapidly, with greater strength and larger staffs, and above all it should not be limited to areas that happen to be of known economic value just at the present moment. It is almost a truism that the scientific principle of to-day is the economic instrument of to-morrow, and it will be a good investment to enlarge the bounds of geological theory, trusting to the inevitable result that every new principle and fact discovered will soon find its economic application. Further, it is necessary that we should obtain as soon as possible a better knowledge of the mineral resources of the smaller and thinly inhabited colonies, protectorates and spheres of influence. This is one of the things which would conduce to the more rapid, effective occupation of these areas.

With regard to areas not at present British colonies, it seems to me that no great harm would be done by obtaining, not in any obtrusive way, some general knowledge of the mineral resources of likely areas. This at least seems to be what other nations find it worth their while to do, and then, when the opportunity of selection arises, they are able to choose such regions as will most rapidly fill up and soonest yield a return for the private or public capital invested in them.

To sum up, I consider that the time has come when geologists should make a firm and consistent stand for the teaching of their science in schools, technical colleges and universities. Such an extension of teaching will of course need the expenditure of time and money; but England is at last beginning to wake up to the belief, now an axiom in Germany and America, that one of the best investments of money that can be made by the pious benefactor or by the state is that laid up at compound interest, 'where neither rust nor moth doth corrupt,' in the brains of its young men.

This knowledge has been an asset of monetary value to hosts of individuals who have made their great wealth by the utilization of our mineral resources, and to our country, which owes its high position among the nations to the power and importance given to it by its coal and iron. It is surely good advice to individuals and to the state to ask them to reinvest some of their savings in the business which has already given such excellent returns, so that they and we may not be losers through our lack of knowledge of those sources of energy which have made us what we are, and are capable of keeping for many years the position they have won for us.

And in our present revival of education it would be well that its rightful position should be given to a science which is useful in training and exercising the faculty of observation and the power of reasoning, which conduces to the open-air life and to the appreciation of the beautiful in nature, which places its services at the disposal of the allied sciences of topography and geography, which is the handmaid of many of

the useful arts, and which brings about a better knowledge and appreciation of the life and growth of that planet which we inhabit for a while, and wish to hand on to our descendants as little impaired in vitality and energy as is consistent with the economic use of our own life-interest in it.

W. W. Watts.

*THE TEACHING OF CHEMISTRY IN GRADED AND SECONDARY SCHOOLS.**

Teachers of science are familiar with the noticeable difference in the attitude of a student when beginning the study of chemistry and when beginning the study of the other sciences. In almost every science but chemistry the student has previously had some familiarity, at least with the material things with which the subject has to deal, while in chemistry the phenomena are all of a decidedly new order. It is hard for a student to become interested in an odorless, tasteless, invisible aggregation of molecules called a 'gas,' while he is immediately interested in the leaf of the botanist, the structure of the frog of the biologist, the mechanical models of the physicist and, indeed, the figures of the geometrician are not without interest when compared with the obscurity of chemical theory.

As a result the teacher of the science other than chemistry has a certain foundation to begin building on. It would, indeed, be an unobserving child who had never perceived leaves, insects and the common mechanical appliances of daily life and consequently had not at least a superficial knowledge of these common objects with which the science deals.

It is undeniably true that the fundamental principles of chemistry are of so complex a nature as to require a more mature mind for their comprehension, but can not the child be made familiar with some of the simpler chemical actions even without understanding why the exact order of phenomena appears? By so doing the mind would be prepared to consider at a later period of development the more important principles without having to delay till the simpler phenomena became familiar.

It here becomes an important question as to how early in a child's life this training should begin. It has, indeed, been jocularly said that a certain professor of organic chemistry in one of our large colleges provided his babies with a set of blocks after the nature of the Kekulé models of the carbon atom.

When we consider the thousand and one things crowded into the life of the child of to-day one hesitates considerably before suggesting another. There has been, however, of recent years, a strong undercurrent of opinion in favor of nature study. The teacher in the kindergarten and the primary and grammar school, by developing the powers of observation and drawing attention to the workings of the laws of nature, is rendering incalculable assistance in teaching the sciences. Unfortunately, chemistry profits the least by this preliminary training.

It was formerly recognized that the beautiful phenomena attending many chemical actions were unusually attractive to children and, indeed, to adults. This was attested by the popularity of the chemical lecture in lyceums, lecture courses, churches, etc.

If I may be pardoned in introducing a bit of personal experience, my interest in the subject was first awakened by a popular lecture on 'A Basket of Charcoal.' I had never seen chemical phenomena before. It was a complete revelation. Obviously

* A paper read before the Chemical Club of Wesleyan University, Middletown, Conn., December 7, 1901.

at the age of twelve I could not understand the reason for any of the wonderful things shown that night, but in attempting to repeat some of the simpler experiments the question naturally arose, as it will to a majority of boys, *why* did this happen? I have been a good deal surprised, in talking with a large number of chemists, to find their first interest in the subject due in many instances to the quickening influences of an experimental lecture. The atomic theory and the theory of valence are not attractive things to the beginner, certainly not to the beginner who is not familiar with some of the facts leading to the adoption of these theories, but the beautiful phenomena of the experimental lecture naturally arouse an interest in chemistry as the beautiful flower awakens an interest in botany.

Some have contended that an interest thus awakened is liable to be of too evanescent a nature; it is wrongly founded; chemistry is like a toy or glittering spectacle soon to be forgotten. I doubt this and firmly believe that in some way or other the child should have the opportunity of seeing these phenomena, if only as a source of pleasure. No harm can be done, the idea suggested by the word chemistry can not be lowered, all the phenomena are of an elevating nature and, granted that only entertainment is obtained, it is a wholesome source of amusement.

If we take this ground, obviously the age at which the phenomena of chemistry can profitably be presented to the child is determined only by his degree of intelligence and ability to perceive. The child a few months old may not appreciate or even observe a brilliantly lighted Christmas tree, while a few months later it might be a source of great delight to him. The pupils in a kindergarten would certainly appreciate a few simple chemical experiments. The grammar school lower grades would of course more fully develop the idea that it was something more than fireworks, while in the higher grades the subject might properly be introduced under the name of chemistry and the pupils themselves could be intrusted with the performance of a few simple experiments. The difficulty of showing chemical experiments is more fancied than real, for with the simplest apparatus, such as glass tumblers, many of the striking color changes may be shown, while the chemicals necessary may be selected so as to be readily obtainable; vinegar, chalk, marble, soda, the common acids, coloring matter of red cabbage, etc., are all such materials. Some dealers put up little packages containing chemicals and apparatus for performing simple experiments at a very small cost. These sets are advertised in the cheap papers throughout the country.

While thus we see that the actual experiment is within the reach of all, there is a very good book written in the conversational style which furnishes to many young people fascinating reading. I refer to the book written by Mrs. Lucy Rider Meyer entitled 'Fairy Land of Chemistry.' No one who picks up this entertaining little book can fail to be impressed with the ingenuity of the writer as well as with the scientific accuracy of the material. In this selection, a fair sample of the general style of the book, two children are in their uncle's laboratory and are looking at a jar of chlorine.

"Where did you get it, Uncle?" asked she.

"Out of salt," replied the Professor.

"Why, Uncle! do you really mean that that green smoke came out of salt—the salt that we eat?"

Professor James looked at his niece with a queer little twinkle in his eyes.

"What do you think about fairies?" asked he.

"Oh! fairies are splendid," answered Jessie, wondering what fairies had to do with salt.

"But they are not real folks, you know. I wish they were.",

"Well," said her uncle, "that gas is nothing more nor less than a collection of real fairies with green dresses on."

Jessie opened her eyes very wide toward the green jar. * * *

"Do they have real legs and arms?" asked she, looking curiously at the green gas.

"They certainly have arms—or rather an arm, for this kind has only one. And I suppose they have legs, for they run around briskly enough sometimes."

"What are their names?" asked Jessie.

"There are so many of them, and they are so small and so much alike, that no mortal has ever been able to get acquainted with them separately. But the wise men who first found out about them, named the whole tribe Chlorine, from the color of the dresses which they wear. Chlorine is taken from a Greek word which means green. But this is only one tribe. There are sixty or seventy others—all different, and all having different names."

"Do they all dress alike?" asked Jessie.

"Each tribe has its own uniform, which is usually the same, but you can find almost every color among different tribes. One tribe—a first cousin to Chlorine—always wears a dark red dress, and there are several that have a wonderful magic cloak that makes them quite invisible."

While this may not be the deepest kind of scientific literature, we must allow that if our children are to listen to fairy stories these are good ones.

It is interesting to note at this point that the conversational style adopted in this book was used very satisfactorily one hundred years ago for books written for children of larger growth. In 1806 Jane Marcet published a book entitled 'Conversations on Chemistry.' A note beneath the catalogue title of this book in H. Carrington Bolton's 'Bibliography of Chemistry' reads: 'This work passed through more than twenty editions, having a success now difficult to comprehend.' The writer, the preface tells us, is an admirer of Sir Humphry Davy, and has attended his lectures at the Royal Institution. The conversation is supposed to take place between a Mrs. B., who is a teacher, and two young ladies. The following selection is characteristic.

Emily. "And how do you obtain the oxy-muriatic acid?"

Mrs. B. "In various ways; but it may be most conveniently obtained by distilling liquid muriatic acid over oxyd of manganese, which supplies the acid with the additional oxygen. One part of the acid being put into a retort, with two parts of the oxyd of manganese, and the heat of a lamp applied, the gas is soon disengaged, and may be received over water, as it is but sparingly absorbed by it. I have collected some in this jar."

Caroline. "It is not invisible like the generality of gases; for it is of a yellowish color."

Mrs. B. "The muriatic acid extinguishes flame, whilst, on the contrary, the oxy-muriatic makes the flame larger, and gives it a dark red color. Can you account for this difference in the two acids?"

Emily. "Yes, I think so; the muriatic acid will not supply the flame with the oxygen necessary for its support; but when this acid is further oxygenated, it will part with its additional quantity of oxygen and in this way support combustion."

Mrs. B. "This is exactly the case; indeed the oxygen added to the muriatic acid adheres so slightly to it that it is separated by mere exposure to the sun's rays. This acid is decomposed also by combustible bodies many of which it burns, and actually inflames, without any previous increase of temperature."

Caroline. "That is extraordinary indeed. I hope you mean to indulge us with some of these experiments?"

Mrs. B. "I have prepared several glass jars of oxy-muriatic acid gas for that purpose. In the first we shall introduce some Dutch gold leaf.—Do you observe that it takes fire?"

The interest aroused in the subject by this little book can be explained, it seems to me, by the nature of the description. There is a vividness to it that a bald statement of fact lacks. The personal element is strong and the minds of at least three persons all considering the same question are reflected in the pages of the book.

It is true, however, that the descriptions are in general much more philosophical and mature than those in a book suitable for children could be, and yet is there not a noteworthy suggestion in the remarkable success of this book? If the conversational style appeals to elders, all the more would it be sure to appeal to the child.

It would seem as if a book might be written adopting this style and treating the subject in a manner suitable for children of the grammar school grade. Bearing in mind that the object of grammar school chemistry is only to familiarize the pupil with chemical phenomena and not to attempt to explain and thus confuse the mind with chemical theories, there seems to be no reason why an interest in things chemical can not legitimately be developed.

In the high school the treatment chemistry should receive is naturally somewhat different. The nature of the phenomena, including perhaps some simple quantitative relations, may properly be studied, the main objects to be gained being: first, increased powers of observation and, second, an accumulation of chemical facts regarding the more common elements and their compounds and a few fundamental laws, especially those of quantity.

To bring the science into closer touch with common life Lassar-Cohn's admirable book, 'Chemistry in Daily Life,' may profitably be read and studied. This plan eliminates practically all chemical theory from a high school course.

It will doubtless be considered heresy to dignify instruction of this nature by the name of chemistry. Should it be said that a student has studied *chemistry* without having had some drill in chemical theory?

It is true that the algebraic expression of a chemical action in the form of an equation may perhaps be used and the idea of symbols elaborated somewhat. Is it best to go much farther? How many pupils in our secondary schools have any conception of chemical theory six months after they have been through the usual course in chemistry? It is the common experience of examiners of candidates for admission to college that the three months intervening between the termination of a high school course and the fall examinations in chemistry for admission to college seem almost entirely to obliterate the slight knowledge of chemical theory possessed by the pupil. Of all chemical knowledge theory goes out of the mind first, chemical facts next and descriptions of apparatus last. It has frequently been my experience that if, for example, a candidate for admission to college is asked how he made oxygen, he invariably starts with the test-tube, cork, delivery-tube, glass bottle and pan of water. Generally at this stage there is a long pause with the chances greatly against his remembering what material was used, and it is seldom that any intelligent grasp of the fundamental principles involved in the chemical action is exhibited.

It seems to me that this condition needs remedial action. The pernicious custom of using stereotyped schemes for records in note books is, I think, one great cause for this unsatisfactory state of affairs. Mechanically entering records under operation, observation and conclusion headings invariably results in an elaborate and needlessly painstaking description of the generally simple apparatus; a less thorough, if anything, too elaborate description of the changes in physical appearance of the materials used and a meager, oftentimes wholly inaccurate, deduction. The result is that what is seen by the eyes and described in detail, *i. e.*, the apparatus and physical characteristics of the material, is longest retained in the memory.

It is in just this point that laboratory in-

struction fails. Students never grasp the idea that the apparatus and the manipulation are simply a means to the end. On the other hand, the skillful lecturer can perform the same experiment, direct the attention to the important phenomena, reiterate the principles involved and leave an impression much less confused and more evenly balanced between the three parts, operation, observation and conclusion.

For grammar school pupils only such record of work as will instil habits of care and accuracy need be demanded. A sketch (no matter how rough) will tell more than pages of description. A word or two may be added to the sketch by way of rendering obscure parts clear, but no further description of apparatus should be encouraged. What is seen may properly be told in a simple, natural way with no attempt on the teacher's part to guide the line of thought. After the book is examined the teacher may then properly designate the non-essentials and emphasize the characteristic changes of substance in the action under consideration. To distinguish between essential and non-essential phenomena is one of the greatest difficulties experienced by the beginner. Conclusions must of necessity be of the most obvious kind with such elementary pupils and no theory should be called for.

In high schools, the pupils being of more mature mind, the record of work should be more carefully supervised. The sketch should still be insisted upon and the actual written description cut down to a minimum. The observations should be given in a natural way with continual caution against undue attention to insignificant details. The phenomena illustrated by experiments performed at this stage of the pupil's chemical education are in general very simple and do not require the eyes of a trained observer. It may be objected that since one feature of chemical training is to train the powers of observation, nothing should be done to designate as insignificant or unimportant any observations properly made. This too is a question that has not been settled satisfactorily to all, but when a student persists in burdening the mind with a lot of unimportant observations at the expense of the fundamental principles, the desirability of eliminating the non-essential is apparent.

Training in the description of an experiment by first stating the principle involved is to my mind the only proper course. When once this is firmly established in the mind and the object of the experiment is clear, the mere recording of manipulation becomes a matter of secondary consideration. Mechanical methods of recording surely are to be avoided.

If, however, this schematic method is retained in the study of qualitative analysis, the reason for its elimination in elementary work may to some seem obscure. The warmest advocates of this system of notation in qualitative analysis must recognize the marked difference in the two cases when it is pointed out that in the elementary laboratory the operations are of widely dissimilar nature and would demand greater breadth of description, while in qualitative analysis the operations are essentially alike.

It can be seen at once that a course in chemistry such as is here proposed would not be in accord with the methods of several hundred text-books written for academies and high schools. The incompatibility would be most noticeable with those consisting in whole or in part of qualitative analysis. Fortunately there are but few treating wholly of qualitative analysis. Of the other class there is unfortunately a yearly increasing number. However, the introduction of qualitative analysis into

secondary schools has but few ardent supporters.

In teaching chemistry in graded and secondary schools would it not be more profitable to spend the time in the laboratory on pure descriptive chemistry, and could not the time spent on abstract chemical theory more profitably be spent emphasizing the relations expressed in the phrase 'The Chemistry of Daily Life'?

FRANCIS GANO BENEDICT.

SCIENTIFIC BOOKS.

Chemical Analyses of Igneous Rocks Published from 1884 to 1900, with a critical discussion of the character and use of analyses. By HENRY STEPHENS WASHINGTON. United States Geological Survey, Professional Paper No. 14. Washington, Government Printing Office. 1903. Pp. 495.

In the first two or three decades of the last century, rocks, in contradistinction to the individually well-defined minerals, were regarded merely as aggregates of minerals in presumably fortuitous combinations and lacking in that definiteness or constancy of composition which would justify their study as a whole. As time went on, however, the chemical aspect of petrography gradually attracted more attention, its great importance being first clearly recognized by Abrich, who in 1841 pointed out the necessity for a knowledge of the chemical composition of rocks in dealing with the problems of their origin and mutual relations as well as for their satisfactory classification and proper nomenclature.

Bunsen's well-known hypothesis that all igneous rocks might be considered as mixtures in various proportions of two supposed original or normal magmas—the trachytic and the pyroxenic—gave a marked stimulus to the study of their chemical composition. But with the abandonment of this view, which broke down under the weight of the evidence accumulated to test it and with the introduction of the microscope as a means of petrographical study in the early seventies, analyses lost much of their interest, being, as Dr. Washington observes, 'inserted perfunctorily in petrographical writings, in obedience to custom, as ornamental embellishments, while the chief efforts of the petrographer were devoted to the elucidation of the purely mineralogical and textural characters of the rocks described.'

During the past ten years, however, the chemical composition of rocks has again attracted much attention—more especially on account of its important bearing on the theoretical side of petrography—the crystallographic and optical properties of the constituent minerals and the details of structure no longer being the only subjects of investigation. The chemical composition of an igneous rock is now recognized as distinctly the most important fact which can be learned concerning it, and the one which is of the greatest value in dealing with the great questions of origin and genetic relations, as well as affording the most reliable basis for classification.

For the study of the chemical composition of rocks, the tables of analyses collected by Roth and which were issued at intervals from 1861 to 1884, have up to the present been the great storehouse of information. They present in tabular form and with certain critical notes practically all the rock analyses which had been published up to the year 1884. Since this latter year, however, a great number of analyses have appeared, in widely scattered journals, proceedings and reports, showing a marked improvement in quality as compared with the old analyses.

In the present volume Dr. Washington has collected all the analyses which have been published during the seventeen years from 1883 to 1900, and has presented them excellently arranged according to the quantitative system of classification recently proposed by him in conjunction with Iddings, Pirsson and Cross, together with full references and with critical notes when required, the whole being introduced by an admirable series of chapters dealing with the character of rock analyses and their bearing on rock classification. The vol-

ume thus extends the work begun by Roth and brings it down to the year 1900, while appendices which will be issued from time to time will serve to keep the work up to date. It is, however, much more valuable than Roth's tables in that the analytical work embraced by it is of a better average quality than the older analytical work and because the analyses collected are not all thrown together irrespective of quality, but are divided into two classes; the 'Superior Analyses,' which judged by the various criteria discussed are believed to be correct, and 'Inferior Analyses,' which are of such a character that deductions based upon them must be regarded as erroneous.

The number of analyses published during the seventeen years in question and which are thus included in Dr. Washington's book is no less than 2,881. These are rated as 'excellent,' 'good,' 'fair,' 'poor,' 'bad.' The three first divisions being grouped as superior analyses are thus worthy of use in petrographical discussion, while the 'poor' and 'bad' analyses are classed as inferior analyses and are considered to be of little or no value. The superior analysis constitutes 64.70 per cent. of the whole, and the inferior analysis, 35.30 per cent.; 'in other words, more than one third of all the analyses which have been made in the seventeen years included by the collection are not worthy of use for general purposes and a very large part of them are useful for no purpose at all.'

As Dr. Washington points out, petrographers have hitherto not been by any means sufficiently exacting in the standard required in rock analyses. The fact has not generally been recognized that the complete and adequate analysis of a rock is one of the most complex and, in some respects, one of the most difficult problems of analytical science, far beyond the capabilities of a novice and demanding not only chemical knowledge and manipulative skill, but often the exercise of considerable judgment derived from experience in solving the perplexing problems which may present themselves. A very large proportion of all the analyses which can be classed as 'excellent' are the work of the chemists of the United States Geological Survey, which shows the preeminent position which they hold in this branch of the science, while the analyses that are now being made by the Geological Survey of New South Wales are of almost equally high standard.

In the case of each of the superior analyses, Dr. Washington has calculated the *norm*, which represents in the aggregate a colossal amount of labor, but the results well repay the labor expended to attain them, for all the rock analyses in recent years are thus placed in their proper position in the quantitative system and the suitability of this system of classification is demonstrated. The exact rating and relative value of each analysis is also given. The book may thus be regarded as a sequel to the 'Quantitative Classification of Igneous Rocks' which was reviewed in Science last February. It tests and illustrates in the most elaborate manner the classification therein proposed. One of the most valuable and interesting portions of the work is that dealing with the errors which are likely to vitiate rock analysis, and how they may be avoided, as well as the methods of judging of and testing the accuracy of an analysis when it has been made.

The book is one of the most important contributions to petrography which has been made for many years, and petrographers are deeply indebted to Dr. Washington for the wide lines on which his book is based and the thoroughness with which it is elaborated. It is a work which gives to the chemical aspects of petrography a new significance.

Frank D. Adams.
McGill University.

DISCUSSION AND CORRESPONDENCE.

STATEMENTS REGARDING EXCHANGES OFFERED BY THE ALLEGHENY OBSERVATORY LIBRARY.

While engaged in rearranging and classifying the books and pamphlets of the Allegheny Observatory library we found that many of our important files of the publications of other observatories and scientific societies were broken and incomplete, but that, on the other hand, we possessed many dupli-

cates. As the same state of affairs exists in many other libraries, it seemed to me that it would be of mutual advantage to ourselves and others to prepare a list giving the names of both our own 'wants' and of the publications we could supply to others, to assist them in completing their files. This was done, and mimeograph copies of the list were distributed to our correspondents and exchanges during the latter part of 1901. The success of the plan was marked, and for some of the volumes on our list more inquiries and requests were received than we could at that time satisfy. In my annual report for that year (1901, p. 13) I suggested that it might be of value to develop this plan of mutual exchanges into a more comprehensive scheme, having for its basis some large central exchange or 'clearing house' to which all astronomical and scientific libraries might send their duplicate papers and publications, and from which they might in return be able to obtain the volumes or numbers of other publications required to complete their own sets. The suggestion has met with favor from many scientific men, and it is hoped that some arrangement may be made for carrying it into effect at an early date. Some expense is of course involved for correspondence and the publication of exchange lists, but a large part of this could be met by the payment of a small annual fee, if a sufficient number of societies and institutions would join in the development of the plan.

Since the publication of our first exchange list two years ago, we have ourselves received a large number of additional duplicates, partly in exchange, and partly by presentation. The most important gift of the latter class was the one from Miss M. W. Bruce, whose valuable donation of her sister's library to our collection was noted and acknowledged in SCIENCE (Vol. XV., p. 758, May 9, 1902) and more fully in my annual report for the same year ('Miscellaneous Scientific Papers of the Allegheny Observatory,' No. 12, p. 9). In order to render these additional duplicates available for distribution we have prepared a new exchange list which will be distributed to our regular correspondents, and will also be sent on request to all interested. Correspondents desiring any of the volumes on this list will kindly indicate the titles of publications they are prepared to offer in return, particularly any of those included in our 'wants,' and we will accept all equitable proposals for such exchanges and fill them in the order in which they are received. It is hardly necessary to state that none of the volumes of this list are for sale, but are only offered in exchange.

In order to determine more fully the possible scope and usefulness of the general plan of a central exchange bureau such as has been proposed above, correspondents are requested to give also a list of the publications which they desire to obtain which are *not* included in our present catalogue, together with a list of all the duplicates in their own library which they would be willing to send to this bureau if it should be established for the purposes indicated. If sufficient interest is manifested and sufficient material offered to meet the mutual 'wants' of those willing to cooperate in this plan, the Allegheny Observatory will undertake to furnish the requisite facilities in the way of storage and packing rooms, and will attend to the assorting, packing and correspondence necessary to effect the exchanges desired on an equitable basis to all parties concerned.

F. L. O. WADSWORTH.

ALLEGHENY OBSERVATORY,
September, 1903.

TOXIC EFFECT OF O AND OH IONS ON SEEDLINGS OF INDIAN CORN.

IN a recent article in these columns* on 'The Toxic Effect of H and OH Ions on Seedlings of Indian Corn,' the author has apparently overlooked my investigations published some seven years ago.† In the part of the article dealing with the effect of H ions upon the seedlings of Indian corn the reader is led to infer that the author is a pioneer.

In my work I tested the effect not only of

* SCIENCE, **18**: 304. 1903.

† 'Toxic Effect of Dilute Solutions of Acids and Salts on Plants,' *Bot. Gaz.*, **22**: 125. 1896.

HCl and H_2SO_4 but also of HNO_3, HBr and $C_2H_4O_2$ upon the seedlings of *Zea Mais*, and arrived at practically the same conclusion. I not only called attention to the fact that the seedlings of Indian corn are much more resistant to H ions than those of *Lupinus albus* used by Kahlenberg and True* but also that they are able to withstand a solution of HCl or H_2SO_4 four times as concentrated as are the seedlings of *Pisum sativum*.

It is true that the exact concentration of H_2SO_4 and HCL which I found to inhibit the growth of corn roots differs somewhat from the figures given by Dr. Loew. This variation in the results may easily be explained by the different methods of experimentation.

F. D. Heald.

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SHORTER ARTICLES.

A LITTLE KNOWN DEVIL-FISH.

In the *Annals and Magazine of Natural History* for August, 1897 (XX., 227), Boulenger published a 'Description of a New Ceratopterine Eagle-Ray from Jamaica,' which he named *Ceratobatis Robertsii.* I was reminded thereby of a species described many years before (1862) by Richard Hill in an article on 'The Devil-fish of Jamaica' in 'The Intellectual Observer' (II., 167–176). Therein he named a small species *Cephaloptera Massenoidea* on account of a supposed resemblance to the *C. Massena* of Risso. I find that Hill's name and article are unknown to ichthyologists generally and, therefore, a note on the subject may be of use at the present time and call attention to some unappreciated facts.

The fish of Boulenger had a disk 13.77 inches long and 30.70 inches wide; the tail was 24.40 inches long. It was assumed that 'this ray grows to a very large size,' and that 'the single specimen secured by Mr. Roberts, the dimensions of which are recorded above, is a young one.'

The species of Hill had a length of 25½ inches 'from the centre of the head to the dorsal fin' and the width was 48 inches; the tail was 30 inches long. It was a female, having 'a fœtus just mature for extrusion, 16 inches broad,' and consequently full grown or at least sexually mature.

Hill's description is not sufficiently full to enable an identification to be made from it alone with Boulenger's specimen. No mention is made of the dentition which is said by Boulenger to be 'restricted to the upper jaw' in his species. Furthermore, there is an apparent discrepancy in the relative proportions, but this may be due to the difference of the points between the measurements. The proportion of the sum of the length of the disk and tail to the width, in Hill's specimen, is not irreconcilable with the proportions of Boulenger's fish. It is improbable, too, that two small species of the same family should be inhabitants of the same waters. Whether there are or are not is a problem for native Jamaican naturalists or visitors to the island to determine.

Boulenger's measurements are given in millimeters; Hill's in feet and inches. Reducing Hill's to millimeters the principal measurements are as follows:

	Boulenger.	Hill.
Length of disk	350	648
Width of disk	780	1,218
Tail	620	762

The difference in size between the species in question and the gigantic devil-fish is remarkable. Another individual (which must have been of another species) was noted by Hill as caught shortly after the one he described which had a disk 15½ feet wide and 9½ feet long and a tail only 2 feet long.

The pregnant mother of the species described by Hill was considerably less in size than the fœtus procured from the body of another female killed in Jamaica many years previously; that fœtus was 'five feet broad.'

Such differences in size even might possibly be within specific variation, but as the differences are coordinate with other structural characters, they can not be in this case.

Theo. Gill.

* *Bot. Gaz.*, **22**: 81. 1896.

SHALL WE DISMEMBER THE COAST SURVEY?*

The proposition to turn the hydrographic work of the Coast Survey over to the Navy Department has been so long urged and so often rejected that its revival at the present moment seems singularly inopportune. Twice at least within the last twenty years it has been exhaustively considered and adversely reported on by committees of Congress when all the circumstances were much more in its favor than they are at present. Prominent treasury officials under the first administration of President Cleveland were known to be so hostile to the management of the survey that an investigation not only unfriendly, but very far from judicial in its character, was undertaken with the approval of the President. The report set forth that abuses had crept into the management, some of them of long standing. The resignation of the superintendent was forced, and it only remained for Congress to take the necessary action to transfer the survey. At the following session a committee of Congress, having Senator Allison at its head, made a thorough investigation of the whole subject. The result of this inquiry was to leave things as they were.

The effort to effect the transfer was renewed with great vigor in 1893. A majority of the naval committee was believed to favor the change, several of its members being warm advocates of the measure. But, after a careful hearing of all that was to be said on both sides, the committee reached a conclusion adverse to the transfer. What has happened since to lead to a change? Nothing whatever. On the contrary, the establishment of the Department of Commerce with the Coast Survey as one of its bureaus removes the last reason for considering the subject. No work is more appropriate to the Department of Commerce than that of providing facilities for navigating our coasts. Charts and soundings are of the first importance not only to our coasting ships and our entire mercantile marine, but to all ships from abroad which enter our ports. Of course, a naval ship has as much need as a merchantman for these means of navigation. There is nothing required on a chart for naval use different from that required for the ordinary purposes of commerce. Accordingly, the Coast Survey was very naturally included among the bureaus to be transferred to the new department.

Extraordinary though the proposition to reverse this action may now appear, the reasons against it are so strong and so near the surface that they hardly need to be cited if the question is to be decided on its merits. Looking at the matter from a purely abstract point of view, the question is whether such a work as that of making charts of our coast can be most efficiently and economically undertaken by the navy or by a civilian organization like the present one. Let us carefully weigh all that is said in favor of the proposed transfer. Hydrographic surveying is part of the business of a naval officer. He learns as much about it while at the Naval Academy as the absorbing character of his other studies will permit. The question whether, during the limited periods which he can possibly devote to such work, he can acquire as much skill as a civilian wholly engaged upon it, is a question which the reader can decide for himself. But the mere fact that naval officers can do the work does not prove that it should be placed under the Navy Department rather than under that of commerce. The arguments on the question whether naval or civilian methods are the more economical have, on the whole, been favorable to the civilians. But even here one important item has been too little considered, and that is the cost of the naval officer himself. The mere salary of the latter is but a part of what it costs the government to educate and train him. In estimating his cost, we must include not only what is expended in his training and his off-duty pay, but his retired pay also. To reach a correct conclusion on this point, we shall probably have to double the pay of every officer of the navy from the time when he gets his first commission up to the date of his retire-

* Editorial in the New York *Evening Post*, September 23, 1903.

ment. Of course, we must include in the estimate the millions being expended at the Naval Academy for the improvement of its facilities. To expend such sums in training officers to perform duty that civilians are now carrying on at far less cost would be a most unjustifiable expenditure of the public money.

The slight reason for the employment of naval officers on civil duty which formerly existed has entirely disappeared with the lapse of time. For several years after the civil war we had more officers than were necessary for the management of our ships and the administration of shore stations. Under these circumstances there was no objection to their employment on such outside service as might be appropriate. But all this has now been changed. The cry in every department of the naval service is for more officers. We hear daily stories of the department's inability to man its ships properly. Why should the service be deprived of its trained officers if this is the case?

The practice of foreign nations has been cited in favor of the proposed action. It is true that the hydrographic surveys of the leading countries of Europe are carried on to a large extent by their respective naval departments. But this statement needs to be supplemented by two others. Both the administration and the personnel of foreign surveys are to a greater or less extent distinct from those which relate to naval duty properly so called. In France the surveys are all conducted by a special corps of 'hydrographic engineers,' and not by line officers at all. In England, by custom, the hydrographer of the admiralty is permanently withdrawn from military duty. He can, of course, be restored to it if such a course is desirable, but practically this is seldom, if ever, done.

These features of foreign hydrographic surveys have always been successfully antagonized by our naval authorities, and we can not suppose that they have changed their minds on the subject. The transfer of the Coast Survey to the Navy Department, whatever may be the intentions of those who favor it, practically means the administration of the survey and the performance of its most difficult work by officers of the navy, each temporarily withdrawn from naval service proper for this special duty, which he is expected to abandon for life about the time when he has obtained a respectable measure of skill in its performance. A civilian organization under the Secretary of the Navy, however plausible it may be made to appear, is an impossibility in the present state of naval opinion.

The law organizing the Department of Commerce gave the President authority to transfer to it bureaus from other departments of the government, that of the navy included. There is good reason to believe that this provision was expected to lead to the inclusion of the National Observatory, and perhaps of the Hydrographic Office also, within the new department. The transfer of the former is loudly called for by all the facts of its history and present position, and if any unification of the government hydrographic surveys is to be carried out, it should be done by transferring the Hydrographic Office also, for it has no necessary relation to the Navy Department whatsoever, and properly belongs to the Department of Commerce.

NUTRITION EXPERIMENTS.

In response to the many inquiries regarding the investigation on nutrition now being carried on at New Haven, Professor Chittenden, Director of the Sheffield Scientific School, has made the following statement:

Through the courtesy of Secretary Root and Surgeon General O'Reilly of the Army, the War Department will cooperate with the Sheffield Laboratory in a physiological study of the minimal amount of proteid or albuminous food required for the maintenance of health and strength under ordinary conditions of life. In carrying out this purpose, twenty men have been detailed from the Hospital Corps of the Army, and will be in New Haven on Monday, under the charge of Lieutenant Wallace DeWitt, Assistant Surgeon in the U. S. Army, and three non-commissioned officers. The Scientific School has fitted up a house on Vanderbilt Square, at the corner of Temple and

Wall streets, where the men will be housed and cared for during the period of the investigation, doubtless for about nine months.

In this study there are no special theories involved and no special systems of dietetics, but the object especially aimed at is to ascertain experimentally whether physiological economy in diet cannot be practiced with distinct betterment to the body and without loss of strength and vigor. There is apparently no question that people ordinarily consume much more food than there is any real necessity for, and that this excess of food is in the long run detrimental to health and defeats the very objects aimed at. It is with a view to gather as many facts as possible on this subject that the study in question is undertaken.

This investigation is merely a continuation, on a larger scale, of earlier observations made in the Sheffield Laboratory of the Sheffield Scientific School last year, and referred to in an article in the *Popular Science Monthly* by Professor Chittenden, and bears directly upon the question of a possible physiological economy in nutrition.

THE BUREAU OF FISHERIES.

On the first of last July the United States Commission of Fish and Fisheries, until then an independent bureau not attached to any government department, became a part of the new Department of Commerce and Labor.

With the transfer the name was changed. The 'United States Commission of Fish and Fisheries' is now a thing of the past, so far as the name is concerned, and it will hereafter be known as the 'Bureau of Fisheries,'—a title certainly much shorter and more usable than the old. Many of us loved the title under which this branch of our government gained and still maintains an honored name among biologists, fish-culturists and anglers throughout the world, cumbersome and unwieldy as that title was; but we welcome the more simple name and have no doubt but that the 'Bureau of Fisheries' will soon become equally honored and well known.

The principal positions in the Bureau of Fisheries and the men who fill them are as follows:

Commissioner, Hon. Geo. M. Bowers.

Deputy Commissioner, Dr. H. M. Smith.

Assistant in Charge of Scientific Inquiry and Ichthyologist, Dr. Barton Warren Evermann.

Assistant in Charge of Fish Culture, Mr. John W. Titcomb.

Assistant in Charge of Statistics and Methods of the Fisheries, Mr. A. B. Alexander.

Chief Clerk, Mr. Irving H. Dunlap.

Disbursing Officer, Mr. W. P. Titcomb.

Engineer and Architect, Mr. Hector von Bayer.

SCIENTIFIC NOTES AND NEWS.

Sir William Ramsay, the eminent British chemist, and M. Henri Poincaré, the eminent mathematical physicist, have been elected corresponding members of the Vienna Academy of Sciences.

Professor M. Allen Starr, M.D., LL.D., of the Medical Department of Columbia University, of New York, has been elected a corresponding member of the Neurological Society of the United Kingdom, London. Dr. Weir Mitchell is the only other American member.

The International Geological Congress awarded its Spendiarow prize to Professor W. C. Brogger of Christiania.

Professor C. S. Sherrington, of the University of Liverpool, gave the address at the opening of the new medical buildings of the University of Toronto, which have been fully described in Science. Professor Sherrington will visit some of the medical centers of the United States before returning to England.

Professor Theodore William Richards, having recovered from his illness, has been made chairman of the Division of Chemistry in Harvard University, in place of Professor Charles Loring Jackson. Professor Jackson retains the Erving professorship and all his other work in research and instruction, resigning the chairmanship alone.

Dr. W. W. Campbell, director of the Lick Observatory, was expected to lecture this week at Wellesley College, on 'The Motions of the Solar System through Space.'

DR. LOUIS PARKES has been appointed consulting sanitary adviser to the British Department of Public Works and Buildings to succeed the late Professor Corfield.

MR. CHARLES LOUIS POLLARD, assistant curator in the Botanical Department of the United States National Herbarium, has been granted a furlough for the period of two and one half years. He will spend this time in Springfield, Mass., being occupied in literary work on the staff of the G. and C. Merriam Company.

DR. GERVASE GREEN, formerly instructor in psychology in Yale University, has returned from a year spent abroad, and will enter a law office in Omaha.

PROFESSOR GARMAN, professor of philosophy at Amherst, has been given leave of absence during the year. His courses will be given by Professor A. H. Pierce, of Smith College. Professor F. J. E. Woodbridge, of Columbia University, will give a course of lectures during the winter on 'Representative Philosophers.'

CHARLES E. CASPERI, Ph.D., has resigned his position as director of the Research Laboratory of the Mallinckrodt Chemical Works, of St. Louis, to accept the chair of chemistry in the St. Louis College of Pharmacy.

THE Associated Press has received a despatch stating that Dr. F. A. Cooke and his party failed to reach the summit of Mount McKinley, but have made various geographical observations in the vicinity.

THE Swiney lectures on geology in connection with the British Museum of Natural History, will be given by Dr. John S. Flett during November. The lectures, twelve in number, are on the volcanoes of the world.

WE learn from *Nature* that a movement is in progress for erecting a memorial of James Watt, and at a meeting recently held it was decided that the form the memorial should take should be an institution for scientific research, and an appeal is now being made for funds to carry out the project. Mr. Andrew Carnegie, who is the secretary for America, has promised a subscription of £10,000 towards the object.

MR. C. J. CORNISH has prepared a life of the late Sir William Flower, which will be published by the Macmillans.

PROFESSOR BENJAMIN G. BROWN, for thirty-five years professor of mathematics at Tufts College, died on September 29 at the age of sixty-six years.

PROFESSOR HUDSON A. WOOD died at Vernon, N. Y., on October 28, aged sixty-two years. He had been a teacher of mathematics and was the author of several text-books.

DR. OSKAR SCHNEIDER of Dresden, the geographer, died on September 8, at the age of sixty-two years.

THE Canadian Minister of Marine and Fisheries, Mr. Profontaine, has stated in the House that he is in favor of the government appropriating $80,000 to build a boat for Captain Bernier's polar expedition.

THE National Statistical Institute met at Berlin beginning on September 21. Professor von Iname-Sternegg was elected president.

ACCORDING to *Nature* Professor Graham Kerr has received a letter from Mr. J. S. Budgett in which the latter announces that he has solved the important problem of the development of *Polypterus*. The letter is written from Southern Nigeria and dated August 28. "It appears that Mr. Budgett has been able to fertilize a large quantity of eggs of *Polypterus senegalus*, and that the early development is 'astoundingly frog-like'—segmentation being complete and fairly equal, and the process of invagination resembling that of the frog's egg. Prominent neural folds are formed which arch over in the normal fashion. Mr. Budgett had already made three expeditions to various parts of tropical Africa in his endeavor to obtain material for studying the development of *Polypterus*, and zoologists will rejoice that his efforts have been at last attended with success. The Crossopterygians have been for some time the most important vertebrate group awaiting the investigation of the embryologist, and the results gained by Mr. Budgett in the working out of his material in the laboratory will be looked forward to

with the greatest interest by all vertebrate morphologists."

The Field Columbian Museum, Chicago, begins its twentieth free lecture course on Saturday afternoons as follows:

October 3, 'A Visit to the Island of Sumatra,' Professor E. E. Barnard, University of Chicago.

October 10, 'A Tour of the Plant World—Japan,' Dr. C. F. Millspaugh, curator, Department of Botany.

October 17, 'Travels on Vancouver Island,' Mr. Harlan I. Smith, American Museum of Natural History, New York, N. Y.

October 24, 'Bird Migration,' Mr. W. E. Praeger, University of Chicago.

October 31, 'On the Isthmus of Tehuantepec,' Dr. Seth E. Meek, assistant curator, Department of Zoology.

November 7, 'In Eastern Mexico,' Dr. Seth E. Meek, assistant curator, Department of Zoology.

November 14, 'Where Sea and River meet,' Dr. Chas. B. Davenport, University of Chicago.

November 21, 'How Ores grow,' Mr. Henry W. Nichols, assistant curator, Department of Geology.

November 28, 'Cats and Dogs, their Origin and Distribution,' Dr. S. W. Williston, associate curator, Division of Paleontology.

We noted recently that Mr. Robert E. Peary had been given three years' leave of absence from the navy to continue his Arctic explorations. It is now stated that Mr. Peary's plan contemplates the construction of a strong wooden ship with powerful machinery, in which he will sail next July to Cape Sabine and, after establishing a subbase there, force his way northward to the northern shore of Grant Land, where he will spend the winter with a colony of Whale Sound Esquimaux, who will be taken there by him from their homes further south. This winter base will be at or in the vicinity of Cape Columbia or Cape Joseph Henry, situated about the 82d degree of north latitude.

We learn from the London *Times* that Mr. W. N. McMillan, who has just returned from a six month's sporting trip in East Africa, has presented to the Zoological Gardens the animals trapped by his men or given him by native chiefs. These include three Arabian baboons (*Papio hamadryas*), three variegated jackals (*Canis variegatus*), two spotted hyenas (*Hyæna crocuta*), one striped hyena (*H. hyæna*), one young lioness (*Felis leo*), one leopard (*F. pardus*), one Abyssinian duiker (*Cephalophus abyssinicus*), and three Somali ostriches (*Struthio molydophanes*). The duiker fills a gap in the Regent's Park menagerie, for till now this species has never been exhibited. Indeed, a good deal of confusion existed about it since it was described by Rüppel, and this was not cleared up till Mr. Oldfield Thomas described all the duikers in a paper presented to the Zoological Society in 1892. Since then the result of his work has been made more generally accessible in the 'Book of Antelopes,' on which he collaborated with Dr. Sclater, the late secretary. The animal is much greyer than the forms living further south, and is also easily distinguished by the median line of dark hair on the face, which ends in a tuft. The suborbital glands are large, and their dark color gives the face a curious appearance. The hair on the front aspect of the fore limbs is dark, and the tail is black above and white on the under surface. The observations of Rüppell and the later ones of Dr. Blanford showed that this antelope lived at high elevation. Mr. McMillan confirms this, and his experience is that it is rarely, if ever, met with on terraces at great elevations, but always on sloping ground. At one time he had three in his camp, all quite tame, but two unfortunately died. The jackals are of interest, as this species differs very widely from others found in North Africa in its lank form and curious coloration of pale buff, washed and blotched with black on the back and tail. The first specimen exhibited at the gardens was sent home in 1894 by the late Dr. Anderson, in whose 'Mammals of Egypt' there is an excellent figure.

UNIVERSITY AND EDUCATIONAL NEWS.

The late Richard W. Foster, of Clinton, Mass., has bequeathed $25,000 to Harvard University. Other public bequests are made, and the residue of the estate is left for a club house for the factory hands of Clinton

under certain conditions. Should these conditions not be fulfilled half the residue of the estate will go to Harvard University.

JUDGE WILLIAM P. BYNUM, of Charlotte, N. C., has given the University of North Carolina $25,000 in memory of his grandson, William Preston Bynum, class '93, who died in his junior year. The money will be used in the construction of a gymnasium, work beginning at once. Mr. John Sprunt Hill, of Durham, N. C., has presented the university with $4,000, the interest from which is to be used for a fellowship in history. The students of the university, by personal canvass during the vacation, raised $8,000 for a Y. M. C. A. hall. Work begins this October.

MR. CEPHAS B. ROGERS, of Meriden, Conn., has given $25,000 to Wesleyan University as a contribution to the fund of $1,000,000 which it is proposed to collect.

DR. JOHN HUSTON FINLEY, professor of politics at Princeton University, was installed as president of the College of the City of New York on the morning of September 29, and on the afternoon of the same day the cornerstone of the new building of the college was laid. In addition to the inaugural address of Dr. Finley, there were numerous addresses. Among those who spoke in the morning were Senator Chauncy M. Depew, Ex-President Cleveland and Presidents Hadley, Butler, Remsen and Schurman. Those who spoke in the afternoon included Mr. Edward M. Shepherd, Professor A. G. Compton, of the college, Mayor Low and Governor Odell.

THE reorganized faculty of the Colorado School of Mines at Golden, Colo., is as follows, the new members being marked with a star:

* President Victor C. Alderson.
Professor H. H. Patton, geology.
Professor A. R. Curtis, machine design.
Professor C. W. L. Filkins, mechanics.
* Professor Herman Fleck, chemistry.
* Professor L. C. Walker, mathematics.
* Professor F. W. Traphagen, metallurgy and assaying.
Assistant Professor W. J. Hazard, descriptive geometry and physics.
* Assistant Professor E. R. Wolcott, physics and electricity.
* Assistant Professor L. E. Young, mining.
* Assistant Professor C. R. Burger, mathematics and surveying.
Mr. C. D. Tost, chemistry.
Mr. W. G. Haldane, mathematics and drawing.
Mr. J. W. Eggleston, geology.
* Mr. J. C. Bailar, chemistry and assaying.
* Mr. C. M. Butler, geology.
* Mr. J. J. Brown, mathematics.

PROFESSOR J. MARK BALDWIN, who has been called to organize a graduate department of philosophy and psychology at the Johns Hopkins University, offers the following courses:

I. *Advanced psychology.* Lectures on general psychology, with attention to physiological psychology and mental pathology. Two hours a week. II. *Philosophical seminary, genetic philosophy and psychology.* Exposition and criticism of the theory of evolution, especially in its application to the mind, and treatment of the principles of mental development in the individual. One hour a week.

In the second half year Professor Baldwin offers in addition a seminar in social psychology and philosophy. Professor Griffin offers a two hour course on modern philosophy from Descartes to Kant, and a one hour course on modern ethical theories.

PRESIDENT SCHURMAN, in his address at the opening of Cornell University, as customary, gave the figures for attendance as shown by registration at that date, September 25, noon. The registration was still incomplete. The attendance was greater than at the same time in any preceding year; the number of upper classmen was larger, the number of new students was greater and the gain was greater than even at the opening of the last year. The Scientific Department gained more than the academic. Sibley College, for example, registers, according to the detailed statistics, over ten per cent. increase; the freshman class numbering about 325, the upper classes averaging about 200 and the total exceeding 900, a larger figure than that of the total registration in any earlier year in its history. The list of graduate students is largely increased, and many are registered in the undergraduate

courses. Throughout the university the classes are overflowing class-rooms, lecture-rooms and laboratories and causing much embarrassment in the endeavor to secure accommodation. The total registration for the year will exceed 3,000, and new buildings, enlarged equipment and an increased instructing staff are imperatively needed.

THE *Daily Palo Alto* reports that the number of new students at Stanford University is 437. The distribution among the departments this year and last is as follows:

	1902.	1903.
Greek	8	2
Latin	23	17
German	30	25
Romanic language	17	15
English	70	90
Philosophy	7	—
Psychology	2	1
Education	8	7
History	33	31
Economics	23	21
Law	57	58
Drawing	6	8
Mathematics	11	3
Physics	2	1
Chemistry	21	21
Botany	9	4
Physiology	18	16
Zoology	4	6
Entomology	—	4
Geology and mining	43	27
Civil engineering	22	29
Mechanical engineering	24	12
Electrical engineering	27	39

THE Iowa State College at Ames has annually an excursion day on which the people of the state are invited to visit the college. This day was celebrated on September 25, when over 15,000 people were present. Addresses were made by the president of the college, Dr. A. B. Storms and Governor A. B. Cummins.

THE Institute of Pedagogy, a department of the Catholic University of America, instituted in Washington, D. C., last year, began its second term on October 1, as the Cathedral College, Fifty-first Street and Madison Avenue, under the directorship of Dr. E. A. Pace, professor of philosophy at the university. Dr. Moore, of the Paulist Community, who received his doctorate at Washington last June, will conduct the lectures in psychology. Other courses will be given in English, history and the history and principles and methods of education.

AT Harvard University, Dr. Charles Robert Sanger has been promoted to a professorship of chemistry; Mr. Frederick Law Olmsted to the chair of landscape architecture called the Charles Eliot professorship in honor of President Eliot's son, and Dr. E. H. Bradford has been appointed professor of orthopedic surgery in the Medical School.

DR. JOHN WHITE, of the University of Nebraska, has been appointed head of the Department of Chemistry at the Rose Polytechnic Institute, succeeding Professor W. A. Noyes, who, as we have already stated, has become head of the Division of Chemistry of the National Bureau of Standards. Dr. Benton Dales, of Cornell University, has been called to the chair at the University of Nebraska.

DR. NORMAN E. GILBERT, A.B. (Wesleyan), Ph.D. (Johns Hopkins), of Hobart College, has been appointed assistant professor of physics at Dartmouth College. Mr. A. A. Bacon, A.B. (Dartmouth), has been called to the position at Hobart College.

MR. FRANK G. MILLER, of the University of Iowa, has been appointed to the new professorship of forestry in the University of Nebraska.

DR. F. J. POND, for several years a member of the chemical force of the Pennsylvania State College, has accepted the position of assistant professor of engineering chemistry at Stevens Institute, Hoboken, N. J.

MR. FRIEND E. CLARK, Ph.D. (Johns Hopkins), who filled a vacancy in the Department of Chemistry at the West Virginia University during the past academic year, has accepted a position as instructor in chemistry in the Pennsylvania State College.

DR. THOMAS JEHU, of St. John's College, Cambridge, has been appointed to a newly established lectureship on geology at the University of St. Andrews.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 16, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ISODYNAMIC REPLACEMENT OF NUTRIENTS.

THIS term was introduced into physiology by Rubner about 1885 as a concise expression of the results of his experiments upon the relative values in nutrition of the three great classes of nutrients, the proteids, carbohydrates and fats.

It was already well established by the labors of previous investigators, notably of Pettenkofer and Voit in Munich, that, aside from a certain rather small amount of proteids which is indispensable, the animal body possesses a remarkable degree of flexibility as regards the nature of the material which it can use to support its vital processes. Aside from the necessary minimum of proteids, the metabolic activities of the body may be supported, now at the expense of the stored body fat, now by the body proteids, and again by the proteids, the fats or the carbohydrates of the food. Whatever may be true economically, physiologically the welfare of the mature animal is not conditioned upon any fixed relation between the classes of nutrients in its food supply, apart from the minimum requirement for proteids. The problem which Rubner proposed to himself was to determine the relative quantities of the several nutrients which were equivalent to each other in the vital processes of the ani-

mal—in other words, to substitute quantitative for qualitative knowledge.

It is well known that a fasting animal consumes the tissues of its own body to sustain its vital activities. Thus in one of Rubner's experiments a fasting dog oxidized per day the equivalent of 20.51 grams of dry muscular tissue (lean meat) and in addition 75.92 grams of his fat. He was then given 740 grams per day of fresh lean meat. On this ration he was found to oxidize the equivalent of 133.89 grams of dry muscular tissue, but only 30.72 grams of the fat of his body. In other words, the oxidation of 113.38 grams more of muscular tissue derived from the lean meat eaten diminished the draft upon the body-fat of the dog by 45.20 grams. Plainly, these two quantities were equivalent, or, after making some slight corrections, 243 parts of dry lean meat were equivalent to 100 parts of fat. A number of similar experiments were made with extracted meat and with various carbohydrates, while in a few cases fat and carbohydrates were interchanged in the food, and a series of ratios like the above were obtained, varying with the material experimented on.

All these results, however, are purely empirical. They explain nothing. The fact, however, that the nutrients can mutually replace each other through so wide a range, and the other fact that the animal body is essentially a transformer of the potential energy of the food into the kinetic energy of heat and motion, suggest that the nutrients replace each other because they all serve as sources of energy to the organism. Acting on this hint, Rubner proceeded to determine the amounts of energy which the several nutrients could liberate in the body. This, by a well-known principle of thermochemistry, is measured by the difference between the potential energy of the substance and that of the products of its decomposition. The potential energy of the nutrients is measured, for this purpose, by their heats of combustion. In the case of the carbohydrates and fats, the products of their decomposition in the body are (in the carnivora) substantially carbon dioxide and water, which contain no measurable amount of potential energy. With the proteids the case is different. Here we have various partially oxidized compounds contained in feces and urine, the potential energy of which Rubner summarily determined by determining the heats of combustion of the dried excreta. In this way he was able to determine how much energy a given amount of lean meat or fat or starch was capable of liberating in the animal organism, and this amount he called its physiological heat value.

When, now, he came to compare the amounts of the several nutrients from which equal quantities of energy could be liberated in the body with the amounts which were found to replace each other in actual feeding experiments, he obtained a most remarkable correspondence. The first column of the table shows the amounts of the several substances required to liberate the same amount of energy as 100 grams of fat, while the second column shows the amounts which were found to replace 100 grams of fat in the nutrition of the animal.

	Yielding Energy Equal to 100 Grams Fat.	Replacing 100 Grams Fat in the Body.
Lean meat......	235 grams.	243 grams.
Extracted meat..	213 "	225 "
Cane sugar......	235 "	234 "
Starch..........	229 "	232 "
Grape sugar.....	255 "	256 "

The teaching of these figures seems perfectly clear. The nutrients are the fuel of the body—its supply of energy—and they replace each other just in proportion to the energy they are capable of liberating.

This law Rubner called the law of isodynamic replacement.*

This law was based upon the conception that the same laws of energetics which control the chemical changes of so-called dead matter also rule the far more complex ones which occur in the living organism, and that the energy which the animal imparts to its surroundings is simply the transformed energy of its food, or, in other words, that the law of the conservation of energy applies to the animal body. Later experiments by Rubner, directed more specifically to this broader aspect of the question, went far to demonstrate the truth of this conclusion, while the later investigations of Laulanié and especially the very extensive ones of Atwater and his associates, Rosa and Benedict, seem to have placed it beyond question.

It is practically to Rubner, then, whatever suggestions may have been made previously, that we owe the effective introduction into physiology of the conception that the relative values of the several nutrients, except as to the special functions of the proteids, are measured by their physiological heat values, or 'fuel values' as they are called by Atwater. This conception has proved to be a fruitful one and has profoundly influenced the study of animal nutrition.

As is so often the case, however, further study has revealed the necessity for modifications and has shown that in its first form the law of isodynamic replacement was, after all, but a partial statement of the truth.

Rubner's experiments were made with animals in a state of rest and with amounts of food insufficient to cause any storing up of flesh or fat in the body. Under these conditions all the energy set free by the burning of food or tissue to support the vital activities, whatever forms it may temporarily take, finally appears as heat which is imparted to the surroundings of the animal. The law of isodynamic replacement, now, implies that the heat production of such an animal is unaffected, at least below the maintenance requirement, by changes in the amount and kind of food consumed. Thus, if the animal oxidizes while fasting 100 grams of body fat, and if it be then given an amount of starch equivalent in energy to 100 grams of fat, viz., 229 grams, this starch should be burned in place of the fat. That is, there will be simply a substitution of one kind of fuel for another, but no increase in the total heat production.

It is, however, an observation as old as the time of Lavoisier that the consumption of food tends to *increase* the heat production, and the fact has been fully established by a host of subsequent investigators. The taking of food calls into activity a whole set of organs that were previously in a state of relative inactivity. The mastication and swallowing of the food and its passage through the alimentary canal involve a not inconsiderable amount of muscular work. In addition to this the various secreting glands are called into action to supply the digestive fluids, while the resulting chemical and fermentative changes in the food itself add their quota to the heat arising from the muscular and glandular activity. This heat, of course, may aid in keeping the animal warm, but otherwise, so far as we know, it is of no direct use to the organism, while often the body has already a superabundant supply and is really engaged in getting rid of heat.

It appears, then, that the mere supplying of more energy to the body in the shape of food sets up a demand for more energy to

* Conclusions very similar, although not based upon their own investigations, had been previously announced by v. Hoesslin and by Danilewsky.

digest and assimilate this food. The case is analogous to that of a steam-boiler which is fired by means of a mechanical stoker driven by steam from the same boiler. Each pound of coal fed into the fire-box is capable of evolving a certain amount of heat, and that heat is capable of producing a certain quantity of steam. A definite fraction of the latter, however, is required to introduce the next pound of coal into the furnace and, therefore, is not available for driving the main engine.

It is plain, however, that this view of the matter is inconsistent with the law of isodynamic replacement as above stated. If the consumption of food causes an increased expenditure of energy by the body, then we do not have simply a replacement of one kind of fuel by another, such as the law of isodynamic replacement predicates, but in addition an actual stimulation of the combustion. To recur to the previous illustration, to prevent the oxidation of 100 grams of fat in the fasting animal would require not only the 229 grams of starch equivalent in energy to the 100 grams of fat, but also enough more to supply the energy required to digest and assimilate the starch. As a matter of fact, Rubner actually did find that slightly more than the theoretical amount of starch was required, viz., 232 grams instead of 229 grams, and the same was true with the other materials experimented on with the exception of cane sugar.

Such substances as meat, starch and sugar, however, are comparatively easy of digestion, and the latter two, at least, do not call for any large expenditure of energy, so that it is difficult to decide whether the small differences in Rubner's figures are significant or not. A material requiring more digestive work would obviously furnish a more decisive test. Such materials are offered in the food of herbivora, particularly in the so-called 'coarse fodders' (hay, straw, etc.), and the recent completion at the Pennsylvania Experiment Station of a respiration-calorimeter * for experiments with cattle afforded an opportunity to test the question with these animals.

The feed used was a rather coarse timothy hay. The steer was fed a very light ration of the hay, together with a little linseed meal, the whole 'basal ration' being much less than was required to support the animal. On this basal ration the steer produced 9,229 calories of heat in 24 hours. During the same time it was shown that he oxidized 49.2 grams of the proteids and 259 grams of the fat of his body, equivalent to 2,578 calories of energy.

Then 1.2 kilograms of the hay were added to the basal ration. It was shown that, after deducting the various unoxidized wastes, this hay represented a fuel value of 2,840 calories; that is, oxidized to the fullest extent to which the organism was capable of carrying it, could liberate that amount of energy. If, now, the law of isodynamic replacement is applicable to this case, that is, if it was simply a question of substituting one kind of fuel for another, the digestible matter of the hay, yielding 2,840 calories of energy, should have prevented the oxidation of an equivalent amount of body tissue. As a matter of fact it fell far short of doing this. On the increased ration, the daily loss by the body of the animal was 7.2 grams of proteids and 80.6 grams of fat, equivalent to 791 calories of energy, while the heat production in 24 hours was 10,249 calories as compared with 9,229 calories on the smaller

* The apparatus is modeled after that of Atwater and Rosa. It was constructed and is being operated in cooperation by the Bureau of Animal Industry of the U. S. Department of Agriculture and The Pennsylvania State College Agricultural Experiment Station.

ration. While the addition of the hay considerably diminished the loss of tissue by the animal, it at the same time caused an increase of over ten per cent. in the heat production; that is, a portion of its fuel value, instead of taking the place of energy previously derived from the oxidation of tissue, was required for the various processes incident to the digestion and assimilation of the hay and ultimately appeared as heat. The loss of tissue was diminished by 1,787 calories by the addition of hay having a fuel value of 2,840 calories. In round numbers, then, only 63 per cent. of the fuel value of the hay was used by the body in place of the energy previously derived from the oxidation of tissue, instead of 100 per cent. as required by the law of isodynamic replacement, while the remaining 37 per cent. became practically an excretum.

The results of a single experiment are, of course, to be accepted with reserve. At the same time, however, the discrepancy is far too great to be accounted for by any possible errors in the determinations of the amounts of energy involved, while there was not the slightest indication of anything abnormal in the state of the animal or in the conditions of the experiment. We are forced to the conclusion that in this case at least the digestible matter of the food was not isodynamic with body substance, or in other words, that its fuel value was not, as has been ordinarily assumed, a measure of its value for maintenance.

It may perhaps be objected that the mixture of ill-known materials digested from hay is a very different thing from the nearly pure nutrients employed in Rubner's experiments, and that it very naturally has a lower nutritive value. Such an objection, however, while perfectly true, would be irrelevant. It is precisely because these materials require the expenditure upon them of a considerable amount of energy, mechanical and chemical, to fit them for the metabolism of the body, that there is this large loss. The difference is one of degree rather than of kind. The cellulose of hay, for example, undergoes an extensive fermentation in the first stomach of ruminants, yielding methane, carbon dioxide and various organic acids. This fermentation is accompanied by an evolution of heat which becomes largely or wholly waste, since the animal body appears to be unable to convert heat into other forms of energy. Undoubtedly this escape of energy during fermentation constitutes a part, and not improbably a large part, of the 37 per cent. of loss observed with the steer. When starch is fed to a dog, it is converted into dextrins, maltose and isomaltose and finally into dextrose by the action of the various digestive ferments. In this process there is likewise a loss of energy, very much smaller it is true than in the case of the cellulose, but just as really a loss. Similarly, the mechanical work of digestion is far less with pure nutrients than with hay, but is by no means equal to zero.

It was noted above that Rubner's own equivalents show that slightly more than the theoretical amounts of nutrients were required to replace body tissue. The writer recently made a careful compilation of all accessible results bearing on this question. After rejecting two experiments by Rubner with cane sugar, in which values considerably over 100 per cent. were obtained, and which Rubner himself considers of doubtful value, all the other trials give values less than 100 per cent. except one experiment on fat and one early one by Pettenkofer and Voit which gives the impossible value of 115 per cent. The deficit is often small and in some cases may not exceed the probable experimental error, but the general tendency appears signifi-

cant, especially when taken in connection with the very marked result of the experiment on hay.

Quite recently Rubner has published in book form * an elaborate discussion of this question, including the results of later experiments on dogs, in which amounts of fats, carbohydrates or proteids considerably in excess of those required for the simple maintenance of the body were fed. Under these conditions he finds that all these nutrients, but especially the proteids, may cause a marked increase in the heat production of the animal. In other words, he shows that what appears to be true of ruminants below the maintenance requirement is equally true of carnivora when the amount of food consumed is relatively large.

It would appear, then, that the law of isodynamic replacement as it has been commonly taught must be modified. That law, as stated above, is that the 'fuel values,' or 'physiological heat values,' of the several nutrients represent their relative worth to the animal body except for the peculiar constructive function of the proteids. In other words, the food is regarded as the fuel of the vital furnace. The fundamental error of this view lies in the fact that it more or less consciously assumes that the production of heat in the body is an end in itself. The truth appears to be that it is, in a physiological sense, an incident. The energy of the food is needed for the performance of the vital processes. During these processes it undergoes various transformations, but finally the larger part, or in the resting animal all, is degraded into heat, which incidentally serves to maintain the temperature of the body, and, as it would seem, is amply sufficient for this purpose under a wide range of conditions.

Such being the case, the value of a food is not measured by the amount of heat which it can liberate in the body, but by the extent to which its energy is available for the vital processes. When, as in the case of the hay, 37 per cent. of the fuel value is consumed in separating the valuable from the worthless portions and in transporting the former to the point of use, the final net advantage to the animal is represented by the remaining 63 per cent. If the gross receipts of a business are one hundred dollars per day and the running expenses thirty-seven dollars, it is plain that the net receipts are only sixty-three dollars, no matter how necessary the expenses may be.

Of course this has a limit. As the temperature to which an animal is exposed falls, and the consequent draft on the body for heat increases, a point will be reached at which the production of heat is just equal to the demand. Below this point, cold seems actually to stimulate in some way the heat production of the animal. Under these circumstances Rubner appears to have demonstrated that the heat produced by the processes of digestion and assimilation may be of use indirectly by obviating the necessity of burning more tissue to supply the necessary heat, and that consequently at relatively low temperatures the fuel value of the food may be the measure of its worth, that is, that isodynamic replacement may occur. Above a certain temperature and a certain amount of food, however, varying with the kind of animal and with the nature of the food, the law ceases to hold and the specific differences in the availability of nutrients or foods reveal themselves.

But while it thus appears that the law of isodynamic replacement is of but limited application, this should not blind us to the vast importance of Rubner's earlier work. It established a new point of view and

* 'Die Gesetze des Energieverbrauchs bei der Ernährung.'

gave a unity to our conceptions of the function of nutrition which they previously lacked. The law of isodynamic replacement is but a single phase of the question. The fundamental idea is that the vital activities are manifestations of the same energy which is seen in operation throughout the universe, are subject to the same laws and may be studied by similar methods. It is his firm grasp of this broad conception, and not the exact scope or accuracy of a single expression of it, which has given Rubner's investigations their preeminent value.

H. P. ARMSBY.

METHODS OF METEOROLOGICAL INVESTIGATION.*

IN opening the proceedings of the subsection devoted to cosmical physics, which we may take to be the application of the methods and results of mathematics and physics to problems suggested by observations of the earth, the air or the sky, I desire permission to call your attention to some points of general interest in connection with that department which deals with the air. My justification for doing so is that this is the first occasion upon which a position in any way similar to that which I am now called upon to fill has been occupied by one whose primary obligations are meteorological. That honor I may with confidence attribute to the desire of the council of the association to recognize the subject so admirably represented by the distinguished men of science who have come across the seas to deliberate upon those meteorological questions which are the common concern of all nations, and whom we are specially glad to welcome as members of this subsection. Their presence and their scientific work are proof, if proof is required, that meteorologists can not regard meteorological problems as dissociable from Section A; that the prosecution of meteorological research is by the study of the kinematics, the mechanics, the physics or the mathematics of the data compiled by laborious observation of the earth's atmosphere.

But this is not the first occasion upon which the address from the chair of the subsection has been devoted to meteorology. Many of you will recollect the trenchant manner in which a university professor, himself a meteorologist, an astronomer, a physicist and a mathematician, dealt candidly with the present position of meteorology. After that address I am conscious that I have no claim to be called a meteorologist according to the scientific standard of Section A. Professor Schuster has explained—and I can not deny it—that the responsible duty of an office from which I can not dissociate myself is signing weather reports; and I could wish that the duty of making the next address had been intrusted to one of my colleagues from across the sea. But as Professor Schuster has set forth the aspect of official meteorology as seen from the academic standpoint with a frankness and candor which I think worthy of imitation, I shall endeavor to put before you the aspect which the relation between meteorology and academic science wears from the point of view of an official meteorologist whose experience is not long enough to have hardened into that most comfortable of all states of mind, a pessimistic contentment.

Meteorology occupies a peculiar position in this country. From the point of view of mathematics and physics, the problems which the subject presents are not devoid of interest, nor are they free from that difficulty which should stimulate scientific effort in academic minds. They afford a

* Address before the Subsection of Astronomy and Meteorology, British Association for the Advancement of Science. Opening address by the chairman, Southport meeting, 1903.

most ample field for the display of trained intellect, and even of genius, in devising and applying theoretical and experimental methods. And can we say that the work is unimportant? Look where you will over the countries which the British Association may be supposed to represent, either directly or indirectly, and say where a more satisfactory knowledge of the laws governing the weather would be unimportant from any point of view. Will you take the British Isles on the eastern shores of the Atlantic, the great meteorological laboratory of the world, with the far-reaching interests of their carrying trade? or India, where the phenomena of the monsoon show most conspicuously the effects of the irregular distribution of land, the second great meteorological cause, and where recurring famines still overstrain the resources of administration? Take the Australasian colonies and the Cape, which, with the Argentine Republic, where Mr. Davis is developing so admirably the methods of the Weather Bureau, constitute the only land projections into the great southern ocean, the region of 'planetary meteorology,' or Australia, with its periods of paralyzing drought; the Cape, where the adjustment of crops to climate is a question of the hour. Or take Canada, which owns at the same time a granary of enormous dimensions and a large portion of the Arctic Circle. Or take the scattered islets of the Atlantic and Pacific or the shipping that goes wherever ships can go. The merest glance will show that we stand to gain more by scientific knowledge, and lose more by unscientific ignorance of the weather, than any other country. The annual loss on account of the weather would work out at no inconsiderable sum per head of the population, and the merest fraction of success in the prevention of what science must regard as preventable loss would compensate for half a century of expenditure on meteorological offices. Or take a less selfish view and consider for a moment our responsibilities to the general community of nations, the advantages we possess as occupying the most important posts of observation. If the meteorology of the world were placed, as perhaps it ought to be, in the hands of an international commission, it can be no exaggeration to say that a considerable majority of the selected sites for stations of observation would be on British soil or British ships. We can not help being the most important agency for promoting or for obstructing the extension of meteorological science. I say this bluntly and perhaps crudely because I feel sure that ideas not dissimilar from these must occasionally suggest themselves to every meteorologist, British or foreign; and if they are to be expressed—and I think you will agree with me that they ought to be—a British meteorologist ought to take the responsibility of expressing them.

And how does our academic organization help us in this matter of more than parochial or even national importance? There was a time when meteorology was a recognized member of the large physical family and shared the paternal affection of all professors of physics; but when the poor nestling began to grow up and develop some individuality electricity developed simultaneously with the speed of a young cuckoo. The professors of physics soon recognized that the nest was not large enough for both, and with a unanimity which is the more remarkable because in some of these academic circles utilitarianism is not a condition of existence, and pure science, not market value, might be the dominant consideration—with singular unanimity the science which bears in its left hand, if not in its right, sources of wealth beyond the

dreams of avarice was recognized as a veritable Isaac, and the science wherein the fruits of discovery must be free for all the world, and in which there is not even the most distant prospect of making a fortune—that science was ejected ás an Ishmael. Electrical engineering has an abundance of academic representatives; brewing has its professorship and its corps of students, but the specialized physics of the atmosphere has ceased to share the academic hospitality. So far as I know, the British universities are unanimous in dissembling their love for meteorology as a science, and if they do not actually kick it down stairs they are at least content that it has no encouragement to go up. In none is there a professorship, a lectureship or even a scholarship to help to form the nucleus of that corps of students which may be regarded as the primary condition of scientific development.

Having cut the knot of their difficulties in this very human but not very humane method, the universities are, I think, disposed to adopt a method of justification which is not unusual in such cases; indications are not wanting which disclose an opinion that meteorology is, after all, not a science. There are, I am aware, some notable exceptions; but do I exaggerate if I say that when university professors are kind enough to take an interest in the labors of meteorologists, who are doing their best amid many discouragements, it is generally to point out that their work is on the wrong lines; that they had better give it up and do something else? And the interest which the universities display in a general way is a good-humored jest about the futility of weather prophecy, and the kindly suggestion that the improvement in the prediction of the next twenty-four hours' weather is a natural limit to the orbit of an Ishmaelite's ambition.

In these circumstances such an address as Professor Schuster's is very welcome; it recognizes at least a scientific brotherhood and points to the responsibility for a scientific standard; it even displays some of the characteristics of the Good Samaritan, for it offers his own beast on which to ride, though it recommends the unfortunate traveler to dispose of what little clothing the stripping has left to provide the two pence for the host.

It is quite possible that the unformulated opinion of the vast majority of people in this country, who are only too familiar with the meteorological vagaries of the British Isles, is that the weather does just as it pleases; that any day of the year may give you an August storm or a January summer's day; that there are no laws to be discovered, and that the further prosecution of so unsatisfactory a study is not worth the time and money already spent upon it. They forget that there are countries where, to judge by their languages, the weather has so nearly the regularity of 'old time' that one word is sufficient to do duty for both ideas. They forget that our interests extend to many climates, and that the characteristics of the eastern shores of the North Atlantic are not appropriate to, say, western tropical Africa. That may be a sufficient explanation of the attitude of the man in the street, but as regards the British universities dare I offer the difficulty of the subject as a reason for any want of encouragement? Or shall I say that the general ignorance on the part of the public of the scientific aspirations and aims of meteorologists and of the results already obtained is a reason for the universities to keep silence on the subject? With all respect I may say that the aspect which the matter presents to official meteorologists is that the universities are some-

what oblivious of their responsibilities and their opportunities.

I have no doubt that it will at once be said that meteorology is supported by government funds, and that alma mater must keep her maternal affection and her exiguous income for subjects that do not enjoy state support. I do not wish just now to discuss the complexities of alma mater's housekeeping. I know she does not adopt the same attitude with regard to astronomy, physics, geology, mineralogy, zoology or botany, but let that pass. From the point of view of the advancement of science I should like to protest against the idea that the care of certain branches of science by the state and by the universities can be regarded as alternative. The advancement of science demands the cooperation of both in their appropriate ways. As regards meteorology, in my experience, which I acknowledge is limited, the general attitude towards the department seems to be dictated by the consideration that it must be left severely alone in order to avoid the vicious precedent of doing what is, or perhaps what is thought to be, government work without getting government pay, and the result is an almost monastic isolation.

There is too much isolation of scientific agencies in this country. You have recently established a national physical laboratory the breath of whose life is its association with the working world of physics and engineering, and you have put it—where? At Cambridge, or anywhere else where young physicists and engineers are being trained? No; but in the peaceful seclusion of a palace in the country, almost equidistant from Cambridge, Oxford, London and everywhere else. You have established a meteorological office, and you have put it in the academic seclusion of Victoria Street. What monastic isolation is good for I do not know. I am perfectly certain it is not good for the scientific progress of meteorology. How can one hope for effective scientific development without some intimate association with the institutions of the country which stand for intellectual development and the progress of science?

I could imagine an organization which by association of the universities with a central office would enable this country, with its colonies and dependencies, to build up a system of meteorological investigation worthy of its unexampled opportunities. But the cooperation must be real and not one-sided. Meteorology, which depends upon the combination of observations of various kinds from all parts of the world, must be international, and a government department in some form or other is indispensable. No university could do the work. But whatever form government service takes, it will always have some of those characteristics which, from the point of view of research, may be called bondage. On the other hand, research, to be productive, must be free with an academic freedom, free to succeed or fail, free to be remunerative or unremunerative, without regard to government audits or House of Commons control. Research looks to the judgment of posterity with a faith which is not unworthy of the churches, and which is not among those excellent moral qualities embodied in the controller and auditor-general. *Die academische Freiheit* is not the characteristic of a government department. The opportunity which gave to the world the 'Philosophiæ Naturalis Principia' was not due to the state subvention of the deputy mastership of the mint, but to the modest provision of a professorship by one Henry Lucas, of whose pious benefaction Cambridge has made such wonderful use in her Lucasian professors.

The future of meteorology lies, I believe,

in the association of the universities with a central department. I could imagine that Liverpool or Glasgow might take a special interest in the meteorology of the sea; they might even find the means of maintaining a floating observatory; and when I say that we know practically nothing of the distribution of rainfall over the sea, and we want to know everything about the air above the sea, you will agree with me that there is room for such an enterprise. Edinburgh might, from its association with Ben Nevis, be desirous of developing the investigation of the upper air over our land; in Cambridge might be found the author of a book on the principles of atmospheric physics, worthy of its Latin predecessor; and for London I can assign no limited possibilities.

If such an association were established I should not need to reply to Professor Schuster's suggestion for the suppression of observations. The real requirement of the time is not fewer observations, but more men and women to interpret them. I have no doubt that the first expression of such an organization would be one of recognition and acknowledgment of the patience, the care, the skill and the public spirit—all of them sound scientific characteristics—which furnish at their own expense those multitudes of observations. The accumulated readings appal by their volume, it is true, but they are, and must be, the foundation upon which the scientific structure will be built.

So far as this country is concerned, when one puts what is in comparison with what might be it must always be acknowledged that the tendency to pessimistic complaisance is very strong. Yet I ought not to allow the reflections to which my predecessor's address naturally gave rise to be too depressing. I should remember that, as Dr. Hellmann said some years ago, meteorology has no frontiers, and each step in its progress is the result of efforts of various kinds in many countries, our own not excluded. In the presence of our guests to-day, some of whom know by practical experience the advantages of the association of academic liberty with official routine, remembering the recent conspicuous successes in the investigation of the upper air in France, Germany, Austria and the United States, and the prospect of fruitful cooperation of meteorology with other branches of cosmical physics, I may well recall the words of Clough:

> Say not, the struggle nought availeth * * *
> And as things have been, things remain.
>
> If hopes were dupes, fears may be liars;
> It may be, in yon smoke concealed
> Your comrades chase e'en now the fliers,
> And, but for you, possess the field.
>
> For while the tired waves, vainly breaking,
> Seem here no painful inch to gain,
> Far back, through creeks and inlets making,
> Comes silent, flooding in, the main.
>
> And not by eastern windows only,
> When daylight comes, comes in the light;
> In front, the sun climbs slow, how slowly,
> But westward, look, the land is bright.

Official meteorologists are not wanting in scientific ambitions and achievements. It is true that Professor Hann, whose presence here would have been so cordially welcomed, left the public service of Austria to continue his services to the world of science by the compilation of his great handbook, and Snellen is leaving the direction of the weather service of the Netherlands for the more exclusively scientific work of directing an observatory of terrestrial physics; but I am reminded by the presence of Professor Mascart of those services to meteorological optics and terrestrial magnetism that make his place as president of the international committee so natural and fitting; and of the solid

work of Angot on the diurnal variation of the barometer and the reduction of barometric observations for height that form conspicuous features among the many valuable memoirs of the Central Bureau of Paris.

Of the monumental work of Hildebrandsson in association with Teisserenc de Bort on clouds, which culminated quite recently in a most important addition to the pure kinematics of the atmosphere, I hope the authors will themselves speak. Professor Willis Moore's presence recalls the advances which Bigelow has made in the kinematics and mechanics of the atmosphere under the auspices of Professor Moore's office, and reminds us of the debt of gratitude which the English-speaking world owes to Professor Cleveland Abbe of the same office, for his treatment of the literature of atmospheric mechanics.

If General Rykatcheff had only the magnificent climatological 'Atlas of the Russian Empire' to his credit he might well rest satisfied. Professor Mohn's contributions to the mechanics of the atmosphere are examples of Norwegian enterprise in the difficult problems of meteorology, while Dr. Paulsen maintains for us the right of meteorologists to share in the results of the newest discoveries in physics. Davis's enterprise in the far south does much to bring the southern hemisphere within our reach, while Chaves places the meteorology of the mid-Atlantic at the service of the scientific world. Need I say anything of Billwiller's work upon the special effect of mountains upon meteorological conditions, or of the immense services of the joint editors of the *Meteorologische Zeitschrift,* Professor Pernter, of Vienna, and Dr. Hellmann, of Berlin; of Palazzo's contributions to terrestrial magnetism. The mention of Eliot's Indian work, or of Russell's organization of Australian meteorology, will be sufficient to show that the dependencies and colonies are prepared to take a share in scientific enterprise. And if I wished to reassure myself that even the official meteorology of this country is not without its scientific ambitions and achievements, I would refer not only to Scott's many services to science, but also to Strachey's papers on Indian and British meteorology and to the official contributions to marine meteorology.

There is another name, well known in the annals of the British Association, that will forever retain an honored place among the pioneers of meteorological enterprise—that of James Glaisher, the intrepid explorer of the upper air, the Nestor of meteorologists, who has passed away since the last meeting of the association.

I should like especially to mention Professor Hergesell's achievements in the organization of the international investigation of the upper air by balloons and kites, because it is one of the departments which offer a most promising field for the future, and in which we in this country have a good many arrears to make up. I hope Professor Hergesell will later on give us some account of the present position of that investigation, and I am glad that Mr. Rotch, to whose enterprise the development of what I may call the scientific kite industry is largely due, is present to take part in the discussion.

Yet with all these achievements it must be confessed that the progress made with the problems of general or dynamical meteorology in the last thirty years has been disappointing. When we compare the position of the subject with that of other branches of physics it must be allowed that it still lacks what astronomy found in Newton, sound in Newton and Chladni, light in Young and Fresnel, heat in Joule, Kelvin, Clausius and Helmholtz, and electricity in

Faraday and Maxwell. Above all, it lacks its Kepler. Let me make this clear. Kepler's contribution to physical astronomy was to formulate laws which no heavenly body actually obeys, but which enabled Newton to deduce the law of gravitation. The first great step in the development of any physical science is to substitute for the indescribably complex reality of nature an ideal system that is an effective equivalent for the purposes of theoretical computation. I can not refrain from quoting again from Plato's 'Republic' a passage which I have quoted elsewhere. It expresses paradoxically but still clearly the relation of natural philosophy to natural science. In the discussion of the proper means of studying sciences Socrates is made to say: 'We shall pursue astronomy with the help of problems just as we pursue geometry: but we shall let the heavenly bodies alone if it is our design to become really acquainted with astronomy.' What I take to be the same idea is expressed in other words by Rayleigh in the introduction to his 'Sound.' He there points out as an example that the natural problem of a sounding tuning-fork really comprises the motion of the fork, the air and the vibrating parts of the ear; and the first step in sound is to simplify the complex system of nature by assuming that the vibrations of the fork, the air and the ear can be treated independently. Frequently this step is a most difficult one to take. What student of nature, contemplating the infinity of heavenly bodies and unfamiliar with this method of idealism, would imagine that the most remarkable and universal generalization in physical science was arrived at by reducing the dynamics of the universe to the problem of three bodies? When we look round the sciences each has its own peculiar ideals and its own physical quantities: astronomy has its orbits and its momentum, sound its longitudinal vibration, light its transverse vibration, heat its energy and entropy, electricity its 'quantity' and its wave, but meteorology has not yet found a satisfactory ideal problem to substitute for the complexity of nature. I wish to consider the aspect of the science from this point of view and to recall some of the attempts made to arrive at a satisfactory modification of reality. I do not wish to refer to such special applications of physical reasoning as may be involved in the formation of cloud, the thermodynamics of a mixture of air and water vapor, the explanation of optical or electrical phenomena, nor even Helmholtz's application of the theory of gravitational waves to superposed layers of air of different density. These require only conventions which belong already to physics, and though they may furnish suggestions, they do not themselves constitute a general meteorological theory.

The most direct efforts to create a general theory of atmospheric circulation are those which attempt to apply Newtonian dynamics, with its more recent developments on the lines of hydrodynamics and thermodynamics. Attempts have been made, mathematical or otherwise, to determine the general circulation of the atmosphere by the application of some form of calculation, assuming only the sun and a rotating earth, with an atmosphere, as the data of the problem. I confess that these attempts, interesting and ingenious as they are, seem to me to be somewhat premature. The 'problem' is not sufficiently formulated. When Newton set to work to connect the motions of the heavenly bodies with their causes, he knew what the motions of the heavenly bodies were. Mathematics is an excellent engine for explaining and confirming what you know. It is very rarely a substitute for observation, and before we

rely upon it for telling us what the nature of the general circulation of the atmosphere really is, it would be desirable to find out by observation or experiment what dynamical and elastic properties must be attributed to an extremely thin sheet of compressible fluid rotating about an axis with a velocity reaching 1,000 miles an hour, and subject to periodic heating and cooling of a very complicated character. It would be more in consonance with the practice of other sciences to find out by observation what the general circulation is before using mathematics to explain it. What strikes one most about the mathematical treatises on the general circulation of the atmosphere is that what is true about the conclusions is what was previously known from observation. It is, I think, clear that that method has not given us the working ideal upon which to base our theory.

Consider next the attempts to regard atmospheric phenomena as periodic. Let me include with this the correlation of groups of atmospheric phenomena with each other or with those of the sun, when the periodicity is not necessarily regular, and the scientific process consists in identifying corresponding changes. This method has given some remarkable results by the comparison of the sequence of changes in the meteorological elements in the hands of Pettersen and Meinardus, and by the comparison of the variation of pressure in different parts of the globe by Sir Norman Lockyer and Dr. W. J. S. Lockyer; as regards the earth and the sun the subject has reached the stage of productive discussion. As a matter of fact, by continuing this address I am preventing Sir Norman Lockyer from telling you all about it.

For the purpose of dealing with periodicity in any form we substitute for nature an ideal system obtained by using mean values instead of individual values, and leaving out what, from this point of view, are called accidental elements. The simplification is perfectly legitimate. Passing on to the consideration of periodicity in the stricter sense, the process which has been so effective in dealing with tides, the motions of the liquid layer, is very attractive as a means of attacking the problems of the atmosphere, because, in accordance with a principle in dynamics, to every periodic cause there must correspond an effect of the same period, although the relation of the magnitude of the effect to the cause is governed by the approximation of the natural period of the body to that of the cause.

There are two forms of the strict periodic method. One is to examine the generalized observations for periodicities of known length, whether it be that of the lunar rotations or that of sunspot frequency, or of some longer or shorter period. In this connection let me acknowledge a further obligation to Professor Schuster for tacking on to his address of last year a development of his work on the detection of hidden periodicities, by giving us a means of estimating numerically what I may call the reality of the periodicity. The other method is by harmonic analysis of a series of observations, with the view of finding causes for the several harmonic components. I may say that the Meteorological Office, supported by the strong opinion of Lord Kelvin, has favored that plan, and on that account has for many years issued the hourly results for its observatories in the form of five-day means as representing the smallest interval for which the harmonic analysis could be satisfactorily employed. Sir Richard Strachey has given some examples of its application, and the capabilities of the method are by no means exhausted, but as regards the general problem

of dynamic meteorology, harmonic analysis has not as yet led to the disclosure of the required generalization.

I ought to mention here that Professor Karl Pearson, with the assistance of Miss Cave, has been making a most vigorous attempt to estimate the numerical value of the relationship, direct or inverse, between the barometric readings at different places on the earth's surface. The attempt is a most interesting one as an entirely new departure in the direction of reducing the complexity of atmospheric phenomena. If it were possible to find coordinates which showed a satisfactory correlation, it might be possible to reduce the number of independent variables and refer the atmospheric changes to the variations of definite centers of action in a way that has already been approached by Hildebrandsson from the meteorological side.

Years ago, when Buys Ballot laid down as a first law of atmospheric motion that the direction of the wind was transverse to the barometric gradient and the force largely dependent upon the gradient, and when the examination of synchronous charts showed that the motion of air could be classified into cyclonic and anticyclonic rotation, it appeared that the meteorological Kepler was at hand, and the first step towards the identification of a working meteorological unit had been taken—the phenomena of weather might be accounted for by the motion and action of the cyclonic depression, the position of the ascending current, the barometric minimum. The individual readings over the area of the depression could be represented by a single symbol. By attributing certain weather conditions to certain parts of the cyclonic area and supposing that the depression traveled with more or less unchanged characteristics, the vagaries of weather changes can be accounted for. For thirty years or more the depression has been closely watched and thousands of successful forecasts have been based upon a knowledge of its habits. But unfortunately the traveling depression can not be said to preserve its identity in any sense to which quantitative reasoning can be applied. As long as we confine ourselves to a comparatively small region of the earth's surface the traveling depression is a real entity, but when we widen our area it is subject to such variations of path, of speed, of intensity and of area that its use as a meteorological unit is seriously impaired, and when we attempt to trace it to its source or follow it to its end it eludes us. Its origin, its behavior and its end are almost as capricious as the weather itself.

Nor if we examine other cases in which a veritable entity is transmitted can we expect that the simple barometric distribution should be free from inexplicable variations. We are familiar with ordinary motion, or, as I will call it, astronomical motion, wave motion and vortex motion. Astronomical motion is the motion of matter, wave motion the motion of energy, vortex motion the motion of matter with energy, but the motion of a depression is merely the transmission of the locus of transformation of energy; neither the matter nor the energy need accompany the depression in its motion. If other kinds of motion are subject to the laws of conservation of matter and conservation of energy, the motion of the depression must have regard also to the law of dissipation of energy. An atmospheric disturbance, with the production of rainfall and other thermal phenomena, must comply in some way with the condition of maximum entropy, and we can not expect to account for its behavior until we can have proper regard to the variations of entropy. But the conditions are not yet in a form suitable for mathematical calculation, and we have no simple rules

to guide us. So far as meteorology is concerned, Willard Gibbs unfortunately left his work unfinished.

When the cyclonic depression was reluctantly recognized as too unstable a creature to carry the structure of a general theory, Mr. Galton's anticyclones, the areas of high pressure and descending currents, claimed consideration as being more permanent. Professor Köppen and Dr. van Bebber have watched their behavior with the utmost assiduity and sought to find therein a unit by which the atmospheric changes can be classified; but I am afraid that even Dr. van Bebber must allow that his success is statistical and not dynamical. 'High pressures' follow laws on the average, and the quantity we seek is not an average, but an individual.

The question arises, whether the knowledge of the sequence of weather changes must elude us altogether, or will yield to further search. Is the man in the street right, after all? But consider how limited our real knowledge of the facts of atmospheric phenomena really is. It may very well be that observations on the surface will never tell us enough to establish a meteorological entity that will be subject to mathematical treatment; it may be that we can only acquire a knowledge of the general circulation of the atmosphere by the study of the upper air, and must wait until Professor Hergesell has carried his international organization so far that we can form some working idea therefrom of general meteorological processes. But let us consider whether we have even attempted for surface meteorology what the patience of astronomers from Copernicus to Kepler did for astronomy.

Do we yet fully comprehend the kinematics of the traveling depression; and if not, are we in a satisfactory position for dealing with its dynamics? I have lately examined minutely the kinematics of a traveling storm, and the results have certainly surprised me and have made it clear that the traveling depressions are not all of one kinematical type. We are at present hampered by the want of really satisfactory self-recording instruments. I have sometimes thought of appealing to my friends the professors of physics who have laboratories where the reading of the barometer to the thousandth of an inch belongs to the work of the 'elementary class,' and of asking them to arrange for an occasional orgy of simultaneous readings of the barometer all over the country, with corresponding weather observations for twenty-four consecutive hours, so that we might really know the relation between pressure, rainfall and temperature of the traveling depressions; but I fear the area covered would even then hardly be large enough, and we must improve our self-recording instruments.

Then, again, have we arrived at the extremity of our knowledge of the surface circulation of the atmosphere? We know a great deal about the average monthly distribution, but we know little about the instantaneous distribution. It may be that by taking averages we are hiding the very points which we want to disclose.

Let me remind you again that the thickness of the atmosphere in proportion to the earth's surface is not unsatisfactorily represented by a sheet of paper. Now it is obvious that currents of air in such a thin layer must react upon each other horizontally, and, therefore, we can not *a priori* regard one part of the area of the earth's surface as meteorologically independent of any other part. We have daily synoptic charts for various small parts of the globe, and the Weather Bureau extended these over the northern hemisphere for the years 1875 to 1879; but who can say that the

meteorology of the northern hemisphere is independent of that of the southern? To settle that primary question we want a synchronous chart for the globe. As long as we are unable to watch the changes in the globe we are to a certain extent groping in the dark. A great part of the world is already mapped every day, and the time has now arrived when it is worth while to consider what contributions we can make towards identifying the distribution of pressure over the globe. We may idealize a little by disregarding the local peculiarities without sacrificing the general application. I have put in the exhibition a series of maps showing what approximation can be made to an isochronous chart of the globe without special effort. We are gradually extending the possibility of acquiring a knowledge of the facts in that as in other directions. With a little enterprise a serviceable map could be compiled; and when that has been reached, and when we have added to that what the clouds can tell us, and when the work of the aeronautical committee has so far progressed that we can connect the motion of the upper atmosphere with the conditions at the surface, when we know the real kinematics of the vertical and horizontal motion of the various parts of a traveling storm, we shall, if the universities will help us, be able to give some rational explanation of these periodic relations which our solar physics friends are identifying for us, and to classify our phenomena in a way that the inheritors of Kepler's achievements associated with us in this section may be not unwilling to recognize as scientific.

W. N. Shaw.

SCIENTIFIC BOOKS.

Introduction to the Rarer Elements. By Philip E. Browning, Ph.D., Assistant Professor of Chemistry, Yale University. New York, John Wiley & Sons. Pp. viii + 157.

"This small volume, prepared from material used by the author in a short lecture course given at Yale University, is intended to serve as a convenient hand-book in the introductory study of the rarer elements; that is, of those elements which are not always taken up in a general course in chemistry. No attempt has been made to treat any part of the subject exhaustively, but enough references have been given to furnish a point of departure for the student who wishes to investigate for himself. Experimental work has been included except in the case of those elements which are unavailable, either because of their scarcity or because of the difficulty of isolating them."

The above excerpt is taken from the preface of this excellent work. The unusual interest in the so-called rare earths in very recent years has been marked. Doubtless many instructors have wished for a guide to be placed in the hands of students. To be sure, those who have been engaged with investigations along these lines have had at hand Truchot's 'Les Terres Rares,' Herzfeld and Korn's 'Chemie der seltenen Erden' (upon which this book is in a measure founded), as well as such specialized brochures as Koppel's 'Die Chemie des Thoriums,' Giesel's 'Ueber radioaktive Substanzen' and Karl Hofmann's 'Die Radioaktiven Stoffe nach dem gegenwärtigen Stande der Wissenschaftlichen Erkenntnis.' Crookes' 'Select Methods' is classic, but not up to date. Recently the first book on the 'rare earths' published in America came from the pen of Dr. Ohley, but we are not reviewing that work. One almost wonders why such a book as the one under discussion has not been offered before. It comes at a ripe period and well qualified it is to meet a want.

The book is exactly what it pretends to be. The different elements are not taken up in the order of the periodic classification, but each one is treated in a systematic manner; a short history of the discovery, occurrence (with names of the minerals and their accepted formulas, with the average percentage of the particular earth indicated), its extraction, preparation, properties, followed by a

list of the typical compounds known, their characteristics, estimation, separation and finally valuable experimental work for laboratory practise. Numerous references to original papers are given.

To round the work off, consideration is given to platinum and gold, which are without doubt rare metals in some laboratories. Some five pages are allotted to the newly discovered gases in the atmosphere, wherein the fact, not generally known, that Cavendish in 1785 found argon, is alluded to. The last few pages are given to an enumeration of some of the unconfirmed discoveries of new elements within recent times, in fact since 1896. Radium and polonium are disposed of in one paragraph.

There is an index and no advertisements are in the back, for which thanks are due the publishers, who made the book of good appearance.

While in such an abbreviated work the author was confined to well-defined and verified observations, perhaps it might have added value to mention incidentally those uses to which some of the rarer substances are put.

The reviewer is doubtless not familiar with the classification of the author, who places thorium and zirconium in the aluminium group. By analogy according to the oxides, hydroxides and salts, these elements would come in the silicon-titanium group. In the preparation of lanthanum, didymium, etc., no mention is made of the recent elegant electrical methods of Muthmann. In the list of minerals bearing thorium, auerlite is not mentioned. The book does not pretend to contain it all, however.

Every one does not specialize in rare earth chemistry, but the reviewer can not well understand how a teacher of inorganic chemistry can be without some work on the subject. These substances constitute as integral a part of that subdivision of science as any of the other elements.

From the numerous requests for assistance and advice as to literature on the subject, made the reviewer from technical laboratories, it may be well to say that many would do well to have a copy of this book close by. The book is to be commended as fulfilling in a most satisfactory manner what it pretends.

Chas. Baskerville.

Lehrbuch der kosmischen Physik. II., Physik der Atmosphäre. Von Dr. Svante August Arrhenius. Leipzig, S. Hirzel. 1903. 8vo. Pp. viii + 553; 138 figs. and charts.

The author of the 'Lehrbuch der kosmischen Physik,' Dr. Svante August Arrhenius, who is professor of physics at the high school in Stockholm, is already known to meteorologists, chiefly through his researches on the effect of the earth's atmosphere upon solar radiation, and on the relation of the moon's declination to atmospheric electricity and magnetism. The 'Lehrbuch' embraces over 1,000 pages all told, of which between 500 and 600 deal with the physics of the atmosphere. With this second portion of the book this review is alone concerned.

Any one who reads these chapters on the atmosphere with the idea that he will find in them a general account of meteorological phenomena such as is to be had in most of the text-books on meteorology will be disappointed. The author makes no attempt to discuss his subject from such a point of view. He expressly states in his preface that he has tried to avoid matters which are purely astronomical, geological or meteorological, and that he has, so far as possible, discussed only such problems as have close relations with physics and chemistry. We have, therefore, in this 'Lehrbuch' no text-book or reference book on general meteorology, but a discussion of the more directly physical relations of the subject. From this standpoint Dr. Arrhenius has given us an excellent piece of work. It is a compact summary of the most important recent investigations of the physics of the atmosphere, and as such it will prove useful to working meteorologists and physicists. The text, however, contains many mathematical formulæ and numerical data and, therefore, makes decidedly 'heavy' reading. The consideration of the measurement of solar radiation is particularly extended. The chapter on

clouds (VIII.) may be taken as a good example of the difference between the present work and the usual text-book of meteorology, and yet this very chapter is more 'popular' than many in the same book. The principal cloud forms are illustrated by means of one unsatisfactory woodcut on page 642. Indeed, the illustrations are comparatively few in number, considering the size of the book. Regarding the origin of cyclones, Arrhenius says (p. 725) that since we know nothing of the vertical temperature distribution in tropical cyclones there is no argument from that standpoint against the convectional theory, as there is in the case of the extra-tropical, 'which are usually cooler at their centers than in the surrounding air.' It has been found necessary to abandon Ferrel's theory for extra-tropical cyclones, although 'it contains a great deal which fits the conditions in the case.' The Hann theory is quoted from Hann's 'Lehrbuch,' and on page 757, after referring to the investigations of Mr. H. H. Clayton on the cyclones of the United States, the author adds that, in the light of the facts now available, 'these cyclones are to be considered as belonging to an earlier stage of development than the European cyclones.' Besides referring to Mr. Clayton's work on cyclones, reference is also made to the Blue Hill kite and cloud investigations and to the results of the studies on New England thunder-storms, carried on some years ago by the New England Meteorological Society. The results obtained in the recent attempts to prevent hail-storms by means of 'weather shooting' are stated (page 805) to be very doubtful. Chapter XIV. concerns 'Meteorological Acoustics,' which is a new heading in a book on meteorology. Chapter XV. (60 pp.) is an extended discussion of 'Meteorological Optics,' a subject which is receiving much attention in Europe. Chapters XVII. and XVIII. (109 pages) treat at some length the subjects of 'Atmospheric Electricity,' and 'Auroras and Terrestrial Magnetism.'

R. DEC. W.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Physical Chemistry, No. 6, June. 'Adherence of Electrolytic Metal Deposits,' by C. F. Burgess and Carl Hambuechen. A paper calling attention to some of the problems of electro-plating, which should be attacked from a scientific standpoint. 'Chemical, Potential and Electromotive Force,' by Wilder D. Bancroft. A development of the work of Gibbs. 'Electrochemical Analysis and the Voltaic Series,' by J. E. Root. An experimental investigation of the relations between voltage and current in different solutions of the metals which may be determined electrolytically. From these is deduced the voltaic series in each solution used, at the temperatures of 20° and 60°. The theoretical possibilities of separation of the different metals electrolytically is discussed. No. 7, October. 'Electrolytic Copper Refining,' by F. J. Schwab and I. Baum. An interesting piece of experimental work designed to determine the best conditions of current density, temperature, etc., for the economical refining of copper. 'The Composition of the Surface Layers of Aqueous Amyl Alcohol,' by Clara C. Benson. The foam of a solution of amyl alcohol is found to be slightly more concentrated than the solution from which it is derived. The solution strength was determined by a viscosity method, depending upon an ingenious apparatus for the uniform production of drops. 'A Correction,' by Geo. H. Burrows.

The Popular Science Monthly for October opens with a paper by Franz Boas on 'The Decorative Art of the North American Indian,' which is largely devoted to showing that the idea now expressed by a given design may be something that was not intended at the outset. In 'Highways and Byways of Animal Life' Herbert F. Osborn discusses some of the peculiar adaptations of animals and the causes which have led to them. Frederick Adams Woods presents arguments and figures to show 'The Correlation Between Mental and Moral Qualities,' and under the title 'Coöperation, Coercion, Competition' Lindley M. Keasbey considers the three characteristic

systems of industrial organization. Robert E. Moritz treats of 'The Sherman Principle in Rhetoric and its Restrictions,' and Elizabeth M. Howe of 'Educational Endowments in the South,' showing how small they are, the reasons for this condition and some of the educationad needs of the southern states. J. A. Fleming presents the fifth of his series of papers on 'Hertzian Wave Wireless Telegraphy.' The number contains the index to Volume LXIII.

The American Naturalist for August contains the second paper by A. W. Grabau on 'Studies of the Gastropoda' and is devoted to *Fulgur* and *Syncotypus,* comprising an account of their development, the succession of their species in time and genetic affinities. Arthur D. Howard has a paper 'On the Structure of the Outer Segments of the Rods in the Retina of Vertebrates' and Edwin W. Doran discusses the 'Vernacular Names of Animals' and propounds a set of rules for the systematic writing of compound names.

A MONTHLY *Journal de chimie et physique* has been started at Geneva under the editorship of Professor P. A. Guye.

DISCUSSION AND CORRESPONDENCE.

THE FIFTH SATELLITE OF JUPITER.

TO THE EDITOR OF SCIENCE: Will you permit me to call attention to a misstatement in SCIENCE, on page 376, second column, undoubtedly unintentional, and at the same time easy of correction. The observations of the fifth satellite of Jupiter, made in the Department of Astronomy and Astrophysics of the University of Chicago, during the past five years, are stated to have been the only ones obtained during that period. As exceptions to this record, measures of the fifth satellite have been made by Doctor Aitken, at this Observatory, in 1898, published in A. J. No. 436; and in 1900 and 1902, published in L. O. Bull. 28; and a series in 1903, not yet published. Such an oversight can easily occur in making up an extensive report, and the credit of the excellent work done at the Yerkes Observatory is in no way diminished by the full statement of the facts.

R. H. TUCKER.

LICK OBSERVATORY,
UNIVERSITY OF CALIFORNIA.

I owe an apology to Professor Aitken for the remark regarding Jupiter's fifth satellite in President Harper's report. When, at President Harper's request, I prepared the statement on the research work of the department of Astronomy and Astrophysics, I understood that the satellite had not been observed elsewhere. There was of course no intention on my part to omit mention of the important work of Professor Aitken with the great telescope of the Lick Observatory.

GEORGE E. HALE.

INVESTIGATIONS IN PROGRESS AT THE UNIVERSITY OF CHICAGO.

THE article in your issue of September 18, under the above title, exhibits an attitude altogether too prevalent among those in authority in this country, and I think justly deserves criticism. It seems to be assumed that if a lot of investigations with high-sounding titles are being carried on at Chicago University, that institution is correspondingly great as a center of research; and that it is a matter of comparative indifference who is doing the work. "I think it best under all the circumstances not to mention in this statement the specific names of persons thus engaged. In most cases, however, the mention of the subject itself will carry with it a knowledge of the person engaged in the work." So it will, to those who happen to know, and to whom the statement is unnecessary.

There are plenty of 'researches' reported in SCIENCE and elsewhere, which are mere air-bubbles, containing nothing. We know very well that most of the work done at the University of Chicago is by no means of this character; that the university is, indeed, a great research center, an ever-flowing fountain of knowledge. But this is due to the *men* who are there, and to describe the work without mention of the workers is as though some theatrical company were to proudly an-

nounce 'we produce all the plays of Shakespeare,' wholly omitting to mention the names of the actors!

Within the last few days I have learned that Mr. Geo. B. King, janitor of the courthouse at Lawrence, Mass., for seventeen years, has been reduced to the position of assistant janitor. Over him has been put a political favorite. Mr. King is poorly educated, and is surrounded by persons who do not believe in scientific janitors; yet he has been able to discover many new Coccidæ in Massachusetts, and his writings on this group are known to entomologists all over the world. Thus does the *man* come to the front, though everything is against him. Yet it is not always so, and for every one having inborn talent who succeeds, no doubt many fail. Mr. King will have to give up all his work in science, if the new conditions are not altered.

It is to the credit and glory of our universities that they can help men to success; can give the conditions which make success in science possible and easy—*given the men*. But after all, the men are everything.

T. D. A. COCKERELL.

COLORADO SPRINGS, COLORADO.

ARCTIC NOMENCLATURE.

TO THE EDITOR OF SCIENCE: The president of the Royal Geographical Society, Sir Clements R. Markham, in the *Geographical Journal* for July, 1903, Vol. XXII., page 7, note, says: "The land which is divided from Greenland by Smith Sound forms a long island, and as many as seven names have been given to various parts of it—1. North Lincoln, 2. Ellesmere Land, 3. King Oscar Land, 4. Schley Land, 5. Arthur Land, 6. Grinnell Land, 7. Grant Land. It is a geographical necessity that, for purposes of description, there should be a name for the whole island. It was first discovered by Baffin in 1616, and first named Ellesmere by Inglefield in 1853. Its name should, therefore, be Ellesmere Island." A map on page 57 of the same volume shows 'Ellesmere Island' and omits 'Grinnell Land' and 'Grant Land.'

It seems desirable to call the attention of American scientists and geographers to this curious proposition, which, without the slightest notice to American geographers, eliminates the American names given to the most important discoveries by Americans in the Arctic, and minimizes as much as possible any recognition of the work of Kane, Hayes, Hall, Greely and Peary.

EDWIN SWIFT BALCH.

PHILADELPHIA,
October 6, 1903.

GONIONEMUS VERSUS 'GONIONEMA.'

DR. MURBACH (SCIENCE, September 18, 1903, 373) has forgotten to add to his letter the following—*Moral:* when proposing a new name give its derivation.

F. A. B.

SHORTER ARTICLES.

NEW HORTICULTURAL AND AGRICULTURAL TERMS.

THE extension of horticultural and agricultural knowledge and the extensive literature that is appearing on such topics render it necessary that new words and expressions be coined in many places to give more exact expression to our thoughts. The writer is very much opposed to the wholesale introduction of new terms, as they seldom find use outside of an individual writer's papers. In some cases, however, it is absolutely necessary. Terms for scientific usage are ordinarily derived from Greek or Latin and are seldom fitted for the general use of the masses of the people. Words that we expect to be generally used, the writer believes, should, regardless of derivation, be short, euphonious, phonetically spelled, easily pronounced and different from any other word in ordinary use, so that it will not suggest any other meaning than the one desired. If no word fulfilling these requirements and having the proper signification can be derived from classical sources, the writer strongly favors the policy of inventing a short and convenient term with no meaning other than that given it and without reference to derivation classical or otherwise. By using this policy, short euphonious terms can be secured. Why concede to the Greeks and Latins the sole right of coining words and burden ourselves with inadequate, poorly-

suited, classical or foreign terms when much simpler and better terms could easily be formed with half the effort, if we could be freed from the shackles of philology and feel free to make meaningless terms without a pedigree!

The above sentences are thrown in simply to relieve the writer's feelings. For over two years he has been searching for, and asking friends to suggest, a suitable term to apply to those plants that are propagated vegetatively by buds, grafts, cuttings, suckers, runners, slips, bulbs, tubers, etc. The plants grown from such vegetative parts are not individuals in the ordinary sense, but are simply transplanted parts of the same individual, and in heredity and in all biological and physiological senses such plants are the same individual. The word variety is a generic term which may be used to refer to the races of peas, beans, corn, wheat, etc.; to the strains of these or other plants; and to natural varieties of scientific botanists as well as to those sorts where parts of the same individual are separated and grown; but for special reference to the class of plants propagated by relative parts it becomes very necessary to have a particular designation.

Last year the writer suggested the word *strace* to use for such varieties and the term was referred to a committee of the Association of Agricultural Colleges and Experiment Stations for consideration. The term *strace* is a combination of the words 'strain' and 'race,' already in use. Recently Mr. O. F. Cook, of the Department of Agriculture, has called the writer's attention to the Greek word *clon* (κλῶν) meaning a twig, spray, or slip, such as is broken off for propagation, which could be used in the connection desired. After careful consideration the writer believes this word much better suited to the purpose than the word strace which he previously suggested. The Greek words *clados* (κλαδος) and *clema* (κλημα) have practically the same meaning and could be used, but are hardly as suitable. *Clados,* shortened to *clad,* becomes a frequently used English term. *Clema* is one letter longer than *clon.* All in all, the term *clon* seems well adapted to the purpose, and as such a word is urgently demanded for general use the writer would suggest its general adoption.

We have then the generic term *variety,* including groups in cultivation known as *races, strains* and *clons.*

$$\text{Variety}\begin{cases}\text{Races,}\\ \text{Strains,}\\ \text{Clons.}\end{cases}$$

Races in a strict sense are those groups of cultivated plants which have well-marked, differentiating characters, and which propagate themselves true to seed except for slight individual variations.

Strains are groups of cultivated plants derived from races from which they do not differ in visible, taxonomic characters in the ordinary sense, but into which has been bred some intrinsic quality such as a tendency to yield heavily, or a better adaptability to a certain environment. When, for instance, a breeder, by the careful selection of Blue Stem wheat produces a sort of Blue Stem which differs from the original race only in its ability to give greater yields, it would be called a strain of Blue Stem wheat. If, however, he selects Jones Winter Fife and changes it from a velvet chaff to a glabrous chaff, he has produced a new race. It must be admitted that there is no very definite line of demarcation between strains and races.

Added to the above two divisions of varieties we should now have:

Clons, which are groups of plants that are propagated by the use of any form of vegetative parts such as bulbs, tubers, cuttings, grafts, buds, etc., and which are simply parts of the same individual seedling. We could then use such expressions as the following: 'The *clons* of apples, pears, strawberries, etc., are not propagated true to seed, while this is one of the important characters of races of wheat and corn,' and 'The differentiating *clonal* characters of chrysanthemums are mainly in the form and color of the flowers.'

Clon, plural *clons* (pronounced with long o), is a short word, easily pronounced, spelled phonetically and with a derivation which at least suggests its meaning. The writer would

urge it as a suitable term to adopt into general usage.

A second term or expression, to which the writer desires to call attention, is the phrase *transmitting power*, to apply to the faculty which an individual organism has of transmitting its individual peculiarities to its progeny. This expression the writer has used in his papers for several years past,* but is not aware that it has been used in this connection by other writers, although it may have been, as it is an expression that would naturally suggest itself to any one thinking on this subject. *Prepotency* has been generally used in this sense, but this word has three well-recognized different meanings, namely,

1. The faculty which an individual has of transmitting its individual qualities to its progeny without variation or reversion, meaning in this case the strength of its hereditary power.

2. The faculty which one species has of dominating another, with which it is crossed, in transmitting its characters.

3. The faculty which one kind of pollen sometimes possesses in being more potent in producing fecundation and offspring than another.

The first of these meanings is that for which the writer uses the expression *transmitting power*. Professor Hays, of the University of Minnesota, uses the expression (*centgener*) power in a similar manner, but this expression seems hardly applicable for use in any case other than where breeding is being conducted according to the centgener system used by him.

In pedigree and grade breeding the transmitting power of the individual is the factor of prime importance that must be discovered by carefully following the performance of each individual in its progeny.

Herbert J. Webber.
Plant Breeding Laboratory,
Department of Agriculture.

* Yearbook, U. S. Department of Agriculture, 1902, p. 369.

A NEW SPHEROIDAL GRANITE.

Granites and diorites, among the deep seated rocks, occasionally develop spheroidal or orbicular structures which are objects of considerable interest to petrographers, and which are exceptional and striking anomalies among the results of crystallization from fusion. Viewed merely as curiosities they would be of only moderate importance, but furnishing, as they do, an illustration of the order in which rock-making minerals separate from the molten magma and gather in aggregates of regular structure, they are the more worthy of attention. The best known of them have been met in Europe, notably at Fonni in Sardinia; Wirvik, Finland; Slätmossa in Sweden; and especially from Corsica, whose beautiful, spheroidal diorite has found a place in all the larger geological museums of the world. In America they are, if anything, less common. One granite, however, has been met in a boulder at Quonochontogue Beach, near Westerly, R. I., which compares favorably in perfection with those of Europe. A less perfect diorite has also been described from Rattlesnake Bar, El Dorado Co., California.

Last spring the writer came into possession of specimens of an exceedingly striking spheroidal rock, which had been discovered in a glacial boulder, by Mr. Horatio P. Parmelee, near Charlevoix, Mich., a town on Lake Michigan in the northwestern portion of the Lower Peninsula. The boulder was several feet in diameter and the largest piece in the possession of the writer is about fifteen inches wide by twenty inches long by eight inches thick. Through the middle runs a pegmatite vein five inches broad, but consisting of the same minerals as those in the spheroids. In fact, several of the spheroids pass imperceptibly into the pegmatite, their outer halves being normal and well-marked and their inner portions passing gradually into the latter.

The distinct spheroids are two to three inches across, and are usually ellipsoidal in shape, although nearly perfect spheres are not lacking. As is the general experience with these rocks the flattened ellipsoids suggest compression due either to flowing movements while the rock was yet plastic or else to dynamic crushes subsequent to consolidation,

the latter being from other evidence less probable.

The spheroids are a brilliant white in color and resemble albite alone, but the microscopic examination reveals considerable orthoclase in addition to the plagioclase, and also much quartz. The quartz fills interstices between the feldspars. The extinction of the plagioclase upon flakes parallel with the basal pinacoid is so slight that the species is in large part oligoclase, but the thin sections give ground for believing albite also to be present and possibly varieties even more basic than oligoclase. The reflections which are given by some broken nodules show that in instances much the greater portion consists of a single feldspar crystal. Others have but few, relatively large individuals; and still others are radiating aggregates. Where the constituent feldspars are coarse and few the core is marked by a few flakes of black biotite irregularly disseminated. They then cease and the main mass of the nodule is feldspar. Even the core may itself practically fail, the nodule becoming a mere ellipsoid of feldspar.

Where the core is well developed it is due to a considerable richness either of biotite or hornblende, both having been observed, but each in different spheroids. They may, however, and probably do occur together. Well-marked rings of biotite or hornblende may also appear half way or two thirds the way from the center to the circumference.

There is no marked outer border to the nodules such as appears in other cases, the contrast being due to the fact that the general matrix is a very dark aggregate of biotite, hornblende, the two feldspars and quartz. The dark minerals are in very large amount, so that the brilliant white nodules stand out with great distinctness.

It appears from the relations of the minerals that the dark silicates first crystallized, together with some feldspar and quartz, and formed the cores. Next followed a period of formation of little else than feldspar and quartz, varied occasionally by a slight separation of the dark silicates. Finally the residue, greatly impoverished by the loss of so much of the feldspathic material, crystallized as the dark matrix.

During the crystallization the pegmatitic streak also formed, and along its borders developed in part as half spheroids. It does not appear to be a phenomenon subsequent to the development of the nodules, and is not very sharply delimited from the spheroidal rock.

The home of the boulder lies somewhere to the north, probably in Ontario, but, so far as known to the writer, no similar rocks have yet been recorded in this region. Acknowledgments are due, in closing, to Professor A. W. Grabau, through whose kind offices the material was secured.

J. F. Kemp.
Columbia University.

PRESENT KNOWLEDGE OF THE DISTRIBUTION OF DAIMONELIX.

Daimonelix when first discovered, in 1891, was thought to be confined to the elevated tablelands of central Sioux County, Nebraska. In the meantime its range has been extended and it is now known almost throughout the entire Arikaree formation, a tract probably about five hundred miles in diameter, situated in Nebraska, Kansas, South Dakota, Wyoming and Colorado. The more fibrous forms of *Daimonelix* constitute a character so constant as to justify the name Fibrous Arikaree for the upper half of the formation. The writer has traced these fossils as represented by the fibrous forms as far south as Benkleman, on the Kansas-Nebraska line, as far east as Fullerton and Long Pine, Nebraska; as far north as Eagle Nest Butte and White Clay Butte, in the Sioux Indian Reservation in South Dakota; and as far west as Lusk, Guernsey and Bates Hole, in Wyoming. Well-authenticated reports would include northeastern Colorado, but those places only are mentioned which have been visited personally by the writer. *Daimonelix* proper is much more restricted than are the fibrous forms. However, its range has been extended beyond the highlands of central Sioux County as far west as Lusk, Wyoming, and as far east as Eagle Nest Butte, South Dakota.

This does not change essentially the original limits ascribed to *Daimonelix,* for outside of Sioux County, where they occur in enormous numbers, they are found sparingly.

In its wider distribution this singular fossil is thought to be represented by a specimen found in Peissenberg, Germany, and described by Dr. Ludwig von Ammon, 'Geognostischen Jahresheften,' 1900, under the title Vorkommen von 'Steinschrauben' (*Dæmonhelix*) in der Oligocänen Molasse Oberbayerns.

ERWIN H. BARBOUR.

THE UNIVERSITY OF NEBRASKA,
December, 1902.

CURRENT NOTES ON METEOROLOGY.

RAINFALL OF INDIA.

THE latest volume of the valuable series of 'Indian Meteorological Memoirs' (XIV., fol., Calcutta, 1902) is a compilation of the rainfall data for 457 Indian stations through the year 1900. In Volume III. of the 'Memoirs,' Appendix A, Blanford had previously given the monthly rainfalls for various periods ending with December, 1886. The present publication will for some years be the authority on Indian rainfall statistics. Considerable interest has always attached to the rainfall at Cherra Poonjee (as the spelling is in the report under consideration), in the Khasi Hills, north of the head of the Bay of Bengal, which has held the record for the heaviest annual precipitation. According to the latest average, carried through 1900, the mean annual rainfall at this station is 457.80 inches. A new subdivision into the northeast monsoon and the southwest monsoon rainfalls, coming respectively in December–April and May–November, will be found useful by students of special problems in connection with the climatology of India.

TORNADO AT GAINESVILLE, GA., JUNE 1, 1903.

IN an account of the Gainesville tornado of June 1 last, published in the *Monthly Weather Review* for June, mention is made of two facts which show clearly the effect of the sudden expansion of the air in enclosed spaces. In one case the walls of a mill 'fell outward, and the roof was lifted into the air and held suspended for several seconds.' The other concerned a standpipe, fifty feet off the ground, and about fifty feet high. This standpipe was about forty feet in diameter, and covered with a sheet-iron cupola. The latter, 'weighing several tons, was lifted bodily from the top of the standpipe, carried high into the air, and dropped about a hundred feet in front of the mill, killing several persons who had thus far escaped danger.'

WEATHER REPORTS FROM VESSELS AT SEA.

IN the same number of the *Review,* Professor A. G. McAdie notes that daily meteorological reports were received at San Francisco from the cable ship *Silvertown,* while this vessel was laying the American trans-Pacific cable. The first report was received when the vessel was 90 miles off shore, and the last when she was about 2,000 miles away. These reports proved of value in making the weather forecasts at San Francisco.

R. DEC. WARD.

THE MOSELEY EDUCATIONAL COMMISSION.

THE members of Mr. Alfred Moseley's commission have arrived in this country to study our educational system. The commission is informal in character, although it includes official delegates from various institutions. It is expected that about two months will be spent in visiting the chief educational centers of the country, attention being paid to the public school system and to higher education. The members of the commission, all of whom, except three who are expected later, have spent the past week in New York City, are as follows:

Arthur Anderson, J.P., Alderman, and Chairman of Technical Instruction Committee of the West Riding County Council. (Nominated by the County Councils Association.)

W. F. Ayrton, F.R.S., professor of physics in the Central Technical College, ex-President Institute of Electrical Engineers.

Thomas Barclay, LL.B., ex-President Paris Chamber of Commerce.

A. W. Black, J.P., mayor of Nottingham; Chairman of the Nottingham Educational Committee.

R. Blair, M.A., B.Sc., assistant secretary for Technical Instruction of the Department of Agricultural and Technical Instruction, Ireland. (Nominated by Department of Agriculture and Technical Instruction.)

J. Rose Bradford, M.D., F.R.C.S., F.R.S., professor of medicine, University College, London.

G. J. Cockburn, ex-Chairman of the Leeds School Board.

The Rt. Reverend, the Bishop of Coventry, ex-Chairman of the Birmingham School Board.

Harry Coward, president of the National Union of Teachers. (Nominated by the National Union of Teachers.)

The Rev. Professor Finlay, S.J., F.R.U.I., member of the Technical Education Board, Ireland; professor of political economy, University College, Dublin. (Nominated as official representative of the Board of Agriculture and Technical Education of Ireland.)

Percy Frankland, Ph.D., B.Sc., F.R.S., professor of chemistry in the University of Birmingham.

T. Gregory Foster, B.A., Ph.D., assistant professor of English in University College, London, and Secretary to the college.

W. C. Fletcher, M.A., late fellow of St. John's College, Cambridge; Head Master of the Liverpool Institute.

W. H. Gaskell, M.A., M.D., F.R.S., fellow of Trinity Hall, Cambridge; university lecturer in physiology.

The Rev. H. B. Gray, D.D. (Oxford), warden of Bradfield College.

W. P. Groser of the Inner Temple, representing the Parliamentary Industry Committee, and to inquire into legal education.

C. J. Hamilton, B.A. (Cambridge), F.S.S., lecturer in political economy, University College, Cardiff; Secretary to the Commission.

J. R. Heape, Chairman of the Rochdale Technical School.

The Rev. A. W. Jephson, M.A., member of the London School Board.

William Jones, M.P. for Arfon Division of Carnarvon, representing the Parliamentary Industry Committee.

Magnus Maclean, M.A., D.Sc., professor of electrical engineering in Glasgow and West of Scotland Technical College, Glasgow. (Nominated official representative by (1) Glasgow and West Scotland Technical College; (2) Edinburgh School Building; (3) the Technical and Secondary Education Committee of the Ayrshire County Council.)

The Rev. T. L. Papillon, M.A., Vicar of Writtle, Essex. Late fellow and tutor of New College, Oxford; formerly fellow of Merton College.

Herbert R. Rathbone, B.A., Barrister-at-law, member of the Education Committee, and Deputy Chairman of the Committee on Elementary Education, Liverpool.

H. R. Reichel, LL.D., late fellow of All Soul's College, Oxford; Principal of University College of North Wales, Bangor, and member of the Welsh Intermediate Education Board. (Nominated as official representative of the University College of Cardiff, Aberystwyth, and Bangor.)

John Rhys, LL.D., professor of Celtic in the University of Oxford; member of the British Academy and of the Oxford Education Committee. Sometime H. M. Instructor of Schools.

W. Ripper, M.I.S.E., professor of engineering in University College, Sheffield. Member of the Sheffield Education Committee.

Charles Rowley, M.A., J.P., member of the Manchester Education Committee and of the Manchester School of Technology, chairman of the Manchester School of Art.

Sir Albert Kaye Rollit, LL.D., D.C.L., M.P., Vice-President of the London Chamber of Commerce. (Nominated by the Association of Municipal Corporations.)

A. J. Shepheard, chairman of the Technical Education Board of the London County Council.

A. Edmund Spencer, B.A. (Oxford), barrister-at-law, director of Plymouth Girls' High School; member of Plymouth Chamber of Commerce, Executive member of Committee of the Mount Edgecombe Industrial Training Ship. Representing Plymouth.

John Whitburn, member of the Education Committee of Newcastle-on-Tyne.

THE ST. LOUIS MEETINGS.

Reference has been made several times in the course of the year in the columns of Science to the scientific meetings to be held in St. Louis in convocation week, beginning on December 28. The American Association for the Advancement of Science and most of the bodies which commonly meet in affiliation

with the association decided last winter to hold their next meeting in St. Louis, and it was expected that, in continuation of the effort that has been made for the last two years, the American Society of Naturalists and most of the bodies of professional men who have met in affiliation with that society would decide to hold their coming meeting at the same place. Unfortunately the American Society did not reach a decision as to its meeting place until autumn, and in the meantime some of the affiliating bodies had decided on an eastern meeting, though the larger number of them are expected to meet in St. Louis, with the Naturalists, at the time of the American Association meeting.

Desiring and anticipating a large attendance, the scientific and educational interests of St. Louis have organized an efficient local committee, and this committee is now at work on arrangements for the meeting. To facilitate these arrangements, it is desirable that the secretaries of the different sections of the American Association, and of all the other bodies that are to meet there in convocation week, write at the earliest possible date to the local secretary, Professor A. S. Langsdorf, of Washington University, St. Louis, letting him know the estimated seating capacity needed for their meetings, as well as the equipment that will be necessary or desirable, so that the subcommittee on equipment may secure ample provision for each.

It is probable that the meetings will be held in the Central High School, with a possible overflow into adjacent suitable buildings, but there is every reason to believe that if the committee is given prompt and definite information on which to make its arrangements all the meetings can be held so close to one another that those desiring to pass from one section to another or from either to the sessions of any affiliated society can do so without loss of time, thus avoiding some of the difficulties of the meetings last winter. The High School is a modern building with interior telephone service and other conveniences; adequate telephone, mail, express and other facilities will be provided and if it is wished a local telegraph office can be established in it; a considerable number of the rooms are provided with lanterns as a part of their regular equipment, and enough others to secure reasonable convenience for sections that only occasionally use this adjunct can be provided; and arrangements are being made to ensure adequate and reasonably cheap hotel accommodations in the vicinity of the High School, which is within easy reach by trolley service of the railroad station and downtown hotels, while the grounds and buildings of the World's Fair, Washington University, the Academy of Science and the Missouri Botanical Garden are all readily reached from this point, which is centrally situated with respect to the extensive trolley service of the city. Every possible courtesy will be extended to those in attendance at the meetings, by the citizens of St. Louis and the exposition authorities, and it is expected that the transportation committee will secure rates that will make it possible for those living at a considerable distance to attend the meetings without serious expense. It is, therefore, to be hoped that the secretaries of the sections of the American Association and of the Society of Naturalists and all of the societies that are to meet in connection with these organizations will work in co-operation with each other to prepare a general program that will possess the greatest possible homogeneity and convenience and that the local committee may promptly be placed in possession of definite data on which they may provide ample accommodations for all.

SCIENTIFIC NOTES AND NEWS.

The new medical buildings and laboratories of Toronto University, described by Professor A. B. Macallum in a recent issue of Science, were officially opened on October 1. The opening address was given by Professor Charles S. Sherrington, of Liverpool. Speeches were made by representatives of the various institutions, and an address in the evening was made by Professor William Osler, of the Johns Hopkins University. A special convocation was held on October 2, at which the following distinguished visitors received the honorary degree of LL.D. from the university: William Williams Keen, Jefferson Medical College, Philadelphia; William Henry Welch, Johns Hopkins University; William Osler, Johns Hopkins University; Russell Henry Chittenden, Yale University; Charles S. Sherrington, University of Liverpool; Henry Pickering Bowditch, Harvard University (*in absentia*).

Professor von Behring, the eminent pathologist, has been made a member of the Russian privy council.

Professor Charles M. Bristol, of New York University, returned on October 7 from the Bermuda Islands, where he has had charge of the Biological Station. He spent the last three weeks in making a collection of tropical fishes, which are to be exhibited under the auspices of the U. S. Bureau of Fisheries at its salt-water aquarium in St. Louis during the World's Fair of 1904.

Sir Daniel Morris, British Imperial Commissioner of the Department of Agriculture for the West Indies, and Mr. John R. Rovell, of the Agricultural Department of Barbadoes, are at Charleston, to make a study of the cultivation of cotton.

M. Dybowski, the French inspector of colonial agriculture, has been sent on a mission to study the agricultural conditions in Senegal and French Guinea.

Dr. Henry S. Pritchett, president of the Massachusetts Institute of Technology, sailed on October 5 from New York on the steamer *Kronprinz* for Germany. It is expected that he will be absent from Boston for only about four weeks.

Mr. W. N. McMillan, of St. Louis, who recently failed in an attempt to explore the course of the Blue Nile, is returning to this country. He expects to start with another expedition in December.

Dr. G. S. Fraps, assistant professor of chemistry at the North Carolina College of Agriculture and Mechanic Arts, and assistant chemist at the North Carolina Experiment Station, has been appointed assistant chemist to the Texas Experiment Station at College Station.

Mr. Clarence T. Johnston, for several years past assistant in the irrigation investigations of the Department of Agriculture, and in charge of the office at Cheyenne, Wyoming, has resigned to accept the appointment of state irrigation engineer of Wyoming.

Mr. Clarence B. Lane, assistant in dairy husbandry at the New Jersey station, has been appointed assistant chief of the dairy division of the Agricultural Department. He succeeds Mr. Harry Haywood, who resigned during the summer to assume charge of the newly organized agricultural department at the Mount Herman School, near Northfield, Mass.

The French government has appointed a commission to study the causes of the disappearance of the sardine. It consists of M. Vaillant, professor at the Museum of Natural History; M. Domergue, inspector general of marine fisheries; and M. Canu, director of the agricultural station at Bologne-sur-Mer.

Professor Ferdinand Hueppe, of Prague, is giving this month at King's College, London, the Harben lectures of the Royal Institution of Public Health.

The Christian A. Herter lecture, at the Johns Hopkins University, the first of the series established by Dr. and Mrs. Herter, of New York City, a year ago, was given by Dr. Herter on October 6, his subject being 'The Work of Pasteur.'

Among the lecture courses arranged for the present season by the Brooklyn Institute of Arts and Sciences is a course of six lectures

by Professor Harry C. Jones, of the Johns Hopkins University.

Dr. Jacques Loeb, professor of physiology at the University of California, was expected to lecture at Stanford University on October 13, under the auspices of the Sigma Xi Scientific Society.

Professor Davidson has been appointed literary executor under the will of the late Professor Bain. He is empowered to edit a volume of remains and a biography, for which ample materials have been left.

A statue in honor of the eminent French neurologist M. Charcot has been erected at Lemolon-les-Bains.

Mr. Cornelius Van Brunt, of New York city, well known as a botanist and especially for his beautiful reproductions of flowers, died on October 1 at the age of seventy-six years.

Mr. John Allen Brown, the author of numerous contributions to anthropology and geology including a work on paleolithic man in northwest Middlesex, died in London, on September 24, at the age of seventy-two years.

The deaths are also announced of Dr. Rudolf Lipschitz, professor of mathematics at Bonn, and of M. A. Certes, known for his bacteriological researches and formerly president of the French Zoological Society.

The statement having been published that the heavy fall in the shares of the U. S. Steel Corporation would adversely affect the value of the gifts bestowed by Mr. Carnegie, that gentleman has telegraphed as follows: "Skibo Castle, N. B.—Mr. Carnegie never owned any second mortgage bonds or shares of the United States Steel Trust. His bonds are first mortgage, covering all the property, and are not quoted upon the Stock Exchange."

On October 1, the organization of the Wisconsin State Hygienic Laboratory was completed in accordance with the legislative enactment of last winter. The laboratory is located at Madison in connection with the Bacteriological Department of the University of Wisconsin and is expected to cooperate with the State Board of Health in its work. The director of the laboratory is Professor H. L. Russell. Mr. G. J. Marquette has been appointed first assistant. The work of the laboratory will be along the usual lines followed in board of health work.

The American Geologist states that a movement is on foot in the state of Nebraska for the erection at Lincoln of a special building for the use of the Historical Society and the Geological Survey of the state.

The governing body of the Lister Institute of Preventive Medicine announces that the necessary legal formalities in connection with the change of name of this institute have now been completed, the Board of Trade having sanctioned the new name. The institute will therefore now be known as the 'Lister Institute of Preventive Medicine,' instead of the Jenner Institute of Preventive Medicine. The address, Chelsea-gardens, S.W., remains the same.

In pursuance of the British Board of Agriculture and Fisheries Act, 1903, the powers and duties of the Board of Trade under the Salmon and Freshwater Fisheries Acts, the Sea Fisheries Regulation Acts and other Acts relating to the industry of fishing have been transferred from that department to the Board of Agriculture, which is to be styled in future the Board of Agriculture and Fisheries. An additional assistant secretary to the Board of Agriculture and Fisheries for fishery business has been provided for, and the Earl of Onslow has appointed to that position Mr. Walter Edward Archer, who has hitherto held the post of chief inspector of fisheries under the Board of Trade.

The American Geologist states that under the auspices of the Civil Commission in charge of the Philippine Islands and immediately under the supervision of Mr. D. C. Worcester, the secretary of the interior of islands, there has been established a mining bureau. This bureau contemplates a thorough investigation into the natural resources of the principal islands, and has already published a finely printed and illustrated bulletin on the iron ores, prepared by Mr. H. D. McCaskey. This mining bureau desires to secure the services

of a good petrographer and an experienced paleontologist. Inquiries may be addressed to Mr. McCaskey at Fort Sheridan, Ill.

THERE will be a civil service examination on November 11, to fill the position of assistant in soil management, Bureau of Soils, Department of Agriculture, at an annual salary of $1,000 to $1,400 a year.

A MEETING was held at Tacoma, Washington, on October 7, to protest against the government's policy of increasing the reserves in the northwest. The meeting was addressed by Mr. Gifford Pinchot, chief of the Bureau of Forestry, who promised that no unnecessary restrictions should be placed on opening the forest reserves to agriculture or to the proper cutting of timber.

THE Iowa Anthropological Association has been organized with headquarters at Iowa City. Duren J. H. Ward, Ph.D., is the secretary. An anthropological survey of the state is already under way.

AT the last annual meeting of the American Electro-Therapeutic Association, held at Atlantic City, N. J., on September 22, 23 and 24, 1903, the following officers were elected: *President,* Alonso David Rockwell, A.M., M.D., New York, N. Y.; *First Vice-President,* Willis Parsons Spring, A.B., M.D., Minneapolis, Minn.; *Second Vice-President,* William Winslow Eaton, A.M., M.D., Danvers, Mass.; *Treasurer,* Richard Joseph Nunn, M.D., Savannah, Ga.; *Secretary,* Clarence Edward Skinner, M.D., LL.D., New Haven, Conn. The next annual meeting will be held at St. Louis, Mo., on September 13, 14, 15 and 16, 1904.

A SOCIETY for the study of tropical medicine has been organized at Philadelphia, with Dr. Thomas H. Fenton as president, and Dr. Joseph McFarland as secretary.

AN International Sanitary Congress for the Adoption of Means of Defense against Cholera and the Plague opened at Paris on October 10. Representatives of twenty-five powers were present, including Surgeon Anderson, United States Navy, medical inspector of the United States European station; Col. Gorgas, formerly chief sanitary officer of the United States at Havana, and Dr. Giddings, representing the United States.

AN International Congress of Ophthalmology will be held at Lucerne, Switzerland, in September, 1904.

AT the conclusion of the meeting of the Iron and Steel Institute at Barrow-in-Furness, Mr. Charles Kirchhoff tendered on behalf of the American members of the institute an invitation to hold its next annual meeting in New York. The invitation, which was endorsed by the American Institute of Mining Engineers and other important bodies, was accepted on behalf of the institute by Mr. Andrew Carnegie. It is now proposed that the autumn meeting shall take place in New York on October 24, 25 and 26 next year. After the meeting there will be an excursion to Philadelphia, Washington, Pittsburg, Cleveland, Niagara Falls, Buffalo and the St. Louis Exposition, returning to New York on November 10. The institute had a similar trip in 1890.

AN International Congress of School Hygiene will be held at Nuremberg, Germany, on April 4–9, 1904. All persons interested in this subject are eligible to membership, after approval by the local committee. There will be ten sections, as follows: (1) Hygiene of the school building and its appointments. (2) Hygiene of boarding schools. (3) Methods of hygienic research. (4) Hygiene of the mental education. (5) Hygienic instructions for masters and pupils. (6) Bodily training of pupils. (7) Illness, minor ailments, and medical attendance in schools. (8) Children of weak intellect, and schools for their benefit; courses for stutterers, for the blind, deaf and dumb; schools for cripples. (9) Hygiene of the scholars after school hours, holiday camps and organization of evening instruction in school-hygiene for parents. (10) Hygiene of the teachers. The American members of the committee are President Nicholas Murray Butler of Columbia University, Professor W. T. Porter of the Harvard Medical School, and Professor John A. Bergström of the University of Indiana.

THE Marconi Wireless Telegraph Company and Dr. Reginald Fessenden, are defendants in two suits for infringement instituted in the United States Circuit Court at Trenton, N. J., on October 5, by the International Wireless Telegraph Company. The plaintiff claims to have purchased from Professor A. Emerson Dolbear, Tufts College, patents for a system of wireless telegraphy granted on October 5, 1886. Professor Dolbear in an affidavit sets forth that he was the original inventor of the system. He charges that the Marconi Company has been aware of his patent rights and has been repeatedly warned that it was infringing them. The International Company seeks an injunction and damages.

THE Stockholm correspondent of the London *Times* writes that on September 14 the Swedish expedition in the *Frithjof* met the French expedition in the *Français* under Dr. Charcot at Funchal. A letter from a member of the Swedish expedition states that the French ship is very adequately fitted and that the laboratories are extremely well furnished with the best modern instruments. Dr. Charcot has placed himself and his ship at the disposal of Captain Gyldén, who is in charge of the *Frithjof*, and as there is some prospect that the Argentine vessel *Uruguay* may do the same, the relief expedition will be undertaken with three ships in constant communication with each other. Thus there seems every chance of bringing the expedition to a happy and expeditious issue. The *Frithjof* and the *Français* left Funchal together on the evening of September 16 *en route* for Buenos Ayres.

A REUTER telegram from Rio de Janeiro states that the Brazilian chamber has adopted the third reading of the bill to establish an international steerable balloon competition to be held at Rio in 1904, for a prize of 200 contos of reis. The scheme has been submitted to the senate.

ON the recommendation of Rear Admiral Rae, chief of the Bureau of Steam Engineering, the secretary of the navy has appointed a board consisting of Capt. G. A. Converse, Commodore J. A. Perry and Lieutenant Cleland Davis, to report upon the subject of training of line officers of the navy in engineering. In the order constituting the board, the following instructions are given: The board will consider and report upon the subject of engineering instruction and training for officers of the line of the navy involved in the consolidation of the line and Engineering Corps by the Navy Personnel act of Congress of March 2, 1899. The board will report what plan it considers will best qualify officers for the efficient performance of engineering duties. The report will include the recommendations as to: First. The establishment of an engineering school for officers, its character, location, administration and government. In this connection the board will report as to the availability of the engineering experimental station at Annapolis for this purpose. Second. The period in their professional career in which officers should receive this instruction. The report will comprehend all details necessary to a complete understanding of this scheme or any other that the board may propose. The engineering instruction referred to should insure thoroughly efficient care, preservation and management of machinery afloat; but it is directed that the board also report upon the subject of further instruction in engineering for officers who evince a marked aptitude and interest in that branch of the profession and who choose to pursue that study as a specialty. The department desires the board to consider what measures should be adopted in order to insure a sufficient number of officers devoting their attention to engineering and whether the status of such officers shall differ in any respect from that of line officers in general in the corresponding grades.

WE learn from *Nature* that the Great Western Railway Company now offers facilities, in conjunction with the Swindon Education Committee, to their apprentices to enable them to gain technical scientific knowledge. A limited number of selected students may attend day classes at the technical school. They must have spent at least one year in the factory, and must have regularly attended for

at least one session in the preparatory group of evening classes at the technical school. The number of students must be limited to thirty at any one time. For each year's course there will be a competitive examination, successful students passing on from one year's course to the next. The course of study for each year will consist of practical mathematics, practical mechanics, geometrical and machine drawing, heat, electricity and chemistry. Those attending the classes will have their wages paid as if at work in the factory, and the Great Western Railway Company will pay their school fees. The students attending the day classes will be expected to give some time each evening to private study. Students who distinguish themselves will be allowed to spend part of their last year in the drawing office and chemical laboratory. The whole of the arrangements will at all times be under the direction of the chief mechanical engineer.

Dr. Henry M. Leipziger, supervisor of free lectures of the New York City Board of Education, says in his annual report: "The attendance at the scientific lectures is such as to show that the purpose of the lecture course should be to lay especial stress on popularization of science. The great need of our country is an increase in popular technical instruction, and the demand in our land for thoroughly trained workmen is always great. The intelligent workman should be thoroughly equipped in scientific principles, and the lecture course is one medium for giving that general information in scientific subjects which many mechanics lack. For this reason it is hoped that at no distant day two or three well-equipped science halls, where experiments can well be made, will form a feature of the educational plant of the city, and to these halls shall come the very ablest scientists to expound to the thinking people of our city the great principles of science, and elaborate on the great discoveries that are constantly being made. Such lectures will be of inestimable value in improving the intellectual condition of the workingman."

UNIVERSITY AND EDUCATIONAL NEWS.

Ground will be broken shortly at Leland Stanford Junior University for a new library building to be erected at a cost of over $500,000. The building will be given to the university by Mrs. Stanford. It is said that she or Mr. Thomas Welton Stanford may also endow the library without drawing on the permanent funds of the university.

By the will of the late Frederick W. Guiteau, Cornell University receives $100,000 and the residue of the estate, which it is said may amount to a considerable sum.

Mr. J. Ogden Armour, of Chicago, has endowed with $100,000 a chair of orthopedic surgery in St. Joseph's Hospital, Omaha, Nebraska.

An appointment as assistant demonstrator of physiology in the Medical Department of the University of Pennsylvania is open for applications. The appointee will devote his mornings to laboratory teaching, his afternoons to research, and will receive a salary of $500.

Dr. R. E. Hedrick, instructor in mathematics in the Sheffield Scientific School of Yale University, has been called to a chair in the University of Missouri.

Dr. Kenneth L. Mark, son of Professor E. L. Mark of Harvard University, has been appointed instructor in chemistry in Simmons College, Boston.

Dr. D. Hepburn, of the University of Edinburgh, has been appointed to the chair of anatomy in University College, Cardiff, vacant by the removal of Professor A. F. Dixon to Trinity College, Dublin.

At the Heriot-Watt College, Edinburgh, Mr. Roderick M. Shearer, M.A., B.Sc. (Edinburgh), has been appointed chief lecturer in mathematics; Mr. William C. Houston, B.Sc. (Glasgow), to be assistant professor of mechanical engineering; Mr. W. Mansergh Varley, B.A. (Cantab.), Ph.D. (Strasburg), to be assistant professor of physics and electrical engineering; and Dr. Bertram D. Steele, D.Sc. (London), McGill University, to be assistant professor of chemistry.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 23, 1903.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ATOMIC THEORY.[*]

ONE hundred years ago, on October 21, 1803, John Dalton gave this society the first announcement of his famous atomic theory. It was only a slight preliminary notice, a mere note appended to a memoir upon another subject, and it attracted little or no attention. In 1804 Dalton communicated his discovery to Dr. Thomas Thomson, who at once adopted it in his lectures, and in 1807 gave it still wider publicity in a textbook. A year later Dalton published his 'New System of Chemical Philosophy,' and since then the history of chemistry has been the history of the atomic theory. To celebrate Dalton's achievement, to trace its influence upon chemical doctrine and discovery, is the purpose of my lecture. It is an old story, and yet a new one; for every year adds something to it, and the process of development shows no signs of nearing an end. A theory that grows, and is continually fruitful, can not be easily supplanted. Despite attacks and criticisms, Dalton's generalization still holds the field; and from it, as from a parent stem, spring nearly all the other accepted theories of chemistry.

Every thought has its ancestry. Let us briefly trace the genealogy of the atomic theory. In the very beginnings of phi-

[*] The Wilde lecture before the Manchester Philosophical Society, delivered May 19, 1903.

losophy men sought to discover the nature of the material universe, and to bring unity out of diversity. Is matter one thing or many? Is it continuous or discrete? These questions occupied the human mind before recorded history began, and their vitality can never be exhausted. Final answers may be unattainable, but thought will fly beyond the boundaries of knowledge, to bring back, now and then, truly helpful tidings.

To the early Greek philosophers we must turn for our first authentic statements of an atomic theory. Other thinkers in older civilizations, doubtless, went before them; perhaps in Egypt or Babylonia, but of them we have no certain knowledge. There is a glimpse of something in India, but we can not say that Greece drew her inspiration thence. For us Leucippus was the pioneer, to be followed later by Democritus and Epicurus. Then, in lineal succession, came the Roman, Lucretius, who gave to the doctrine the most complete statement of all. In the thought of these men the universe was made up of empty space, in which swam innumerable atoms. These were inconceivably small, hard particles of matter, indivisible and indestructible, of various shapes and sizes, and continually in motion. From their movements and combinations all sensible matter was derived. Except that the theory was purely qualitative and non-mathematical in form, it was curiously like the molecular hypothesis of modern physics, only with an absolute vacuum where an intermediary ether is now assumed. This notion of a vacuum was repellant to many minds; to conceive of a mass of matter so small that there could be none smaller was unreasonable; and hence there arose the interminable controversy between plenists and atomists which has continued to our own day. It is, however, essentially a metaphysical controversy, and some writers have ascribed it to a peculiar distinction between two classes of minds. The arithmetical thinker deals primarily with number, which is, in its nature, discontinuous, and to him a material discontinuity offers no difficulties. The geometer, on the other hand, has to do with continuous magnitudes, and a limited divisibility of anything in space is not easy for him to conceive. But be this as it may, the controversy was one of words rather than of realities, and its intricacies have little interest for the scientific student of to-day. It is always easier to reason about things as we imagine they ought to be, than about things as they really are, and the latter procedure became practicable only after experimental science was pretty far advanced. The Greeks were deficient in physical knowledge, and, therefore, their speculations remained speculations only, mere intellectual gymnastics of no direct utility to mankind. They sought to determine the nature of things by the exercise of reason alone, whereas science, as we understand it, being less confident, seeks mainly to coordinate evidence and to discover the general statement which shall embrace the largest possible number of observed relations. The man of science may use the metaphysical method as a tool, but he does so with the limitations of definite, verifiable knowledge always in view. Intellectual stimulants may be used temperately, but they need not be discarded altogether.

From the time of Lucretius until the seventeenth century of our era, the atomistic hypothesis received little serious attention. The philosophy of Aristotle governed all the schools of Europe, and scholastic quibblings took the place of real investigation. All scholarship lay under bondage to one master mind, and it was not until Galileo let fall his weights from the

leaning tower of Pisa that the spell of the Stagirite was broken. Experimental science now came to the fore, and it was seen that even Aristotelian logic must verify its premises. The authority of evidence began to replace the authority of the schools.

Early in the seventeenth century the atomic philosophy of Epicurus was revived by Gassendi, who was soon followed by Boyle, by Newton and by many others. One other important step was taken also. Boyle, in his 'Sceptical Chymist,' gave the first scientific definition of element, a conception which was more fully developed by Lavoisier later, but which received its complete modern form only after Davy had decomposed the alkalies and shown the true nature of chlorine. Without this preliminary work of Boyle and Lavoisier, Dalton's theory would hardly have been possible. An elementary atom can be given no real definition unless we have some notion of an element to begin with. But the strongest impulse came from Newton, who accepted atomism in clear and unmistakable terms. Coming before Newton, Descartes had rejected the atomic hypothesis, holding that there could be no vacuum in the universe, and making matter essentially synonymous with extension. True, Descartes, in his famous theory of vortices, imagined whirling particles of various degrees of fineness; but they were not atoms as atoms and molecules are now conceived. It may be dangerous to pick out landmarks in history and to assert that such and such a movement began at such and such a time. Nevertheless, we may fairly say that the turning point in physical philosophy was Newton's discovery of gravitation, for that indicated mass as the fundamental property of matter. For any given portion of matter which we can segregate and identify, extension is variable and mass is constant; when that conclusion was established, the dominance of atomism became inevitable. Boyle, Newton and Lavoisier were legitimate precursors of Dalton, but whether Boscovich should be so considered is more than doubtful. His points of force were too abstract a conception to admit of direct application in the solution of real problems. Dalton certainly owed nothing to Boscovich, and would just as surely have developed his theory had the brilliant Dalmatian never written a line.

To Boyle and Newton the atomic hypothesis was a question of natural philosophy alone; for, in their day, chemistry, as a quantitative science, had hardly begun to exist. Attempts were soon made, however, to give it chemical application, and the first of these which I have been able to find was due to Emanuel Swedenborg. This philosopher, whose reputation as a man of science has been overshadowed by his fame as a seer and theologian, published in 1721 a pamphlet upon chemistry, which is now more easily accessible in an English translation of relatively recent date.* It consists of chapters from a larger unpublished work, and really amounts to nothing more than a sort of atomic geometry. From geometric groupings of small, concrete atoms, the properties of different substances are deduced, but in a way which is more curious than instructive. Between the theory and the facts there is no obvious relation. The book was absolutely without influence upon chemical thought or discovery, and, therefore, it has escaped general notice. It is the prototype of a class of speculative treatises, considerable in number, some of them recent, and all of them futile. They represent efforts which were premature, and for which the

* 'Some specimens of a work on the Principles of Chemistry with other treatises.' London, 1847. Originally published at Amsterdam, in Latin.

fundamental support of experimental knowledge was lacking.

In 1775, Dr. Bryan Higgins, of London, published the prospectus of a course of lectures upon chemistry, in which the atomic hypothesis was strongly emphasized. It was still, however, only an hypothesis, quite as ineffectual as Swedenborg's attempt, and it led to nothing. Dr. Higgins recognized seven elements; earth, water, alkali, acid, air, phlogiston and light; each one consisting of 'atoms homogeneal,' these being 'impenetrable, immutable in figure, inconvertible,' and all 'globular, or nearly so.' He speculated upon the attractions and repulsions between these bodies, but he seems to have solved no problem and to have suggested no research. William Higgins, on the other hand, whose work appeared in 1789, showed more insight into the requirements of true science, and had some notions concerning definite and multiple proportions. His conception of atomic union to form molecules was fairly clear, but the distinct statement of a quantitative law was just beyond his reach. In 1814, however, when Dalton's discoveries were widely known and accepted, Higgins published a reclamation of priority.* In this, with much bitterness, he claims to have completely anticipated Dalton, a claim which no modern reader has been able to allow. In Robert Angus Smith's 'Memoir of John Dalton and History of the Atomic Theory,'† the work of Bryan and William Higgins is quite thoroughly discussed, and, therefore, we need not consider the matter any more fully now. We see that atomic theories were receiving the attention of chemists long before Dalton's time, although none of them went much beyond the speculative stage, or was given serviceable form. They were dim foreshadowings of science; nothing more.

In order that a new thought shall be acceptable, certain prerequisite conditions must be fulfilled. If the ground is not prepared, the seed can not be fruitful; if men are not ready, no harvest will be reaped. Only when the time is ripe, only when long lines of evidence have begun to converge, can a new theory command attention. Dalton's opportunity came at the right moment, and he knew how to use it well. Elements had been defined; the constancy of matter was established; pneumatic chemistry was well developed, and great numbers of quantitative analyses awaited interpretation. The foundations were ready for the master builder, and Dalton was the man. His theory could at once be tested by the accumulated data, and when that had been done it was found to be worthy of acceptance.

It is not my purpose to discuss in detail the processes of Dalton's mind. The story is told in his own note-books, which have been given to the public by Roscoe and Harden,* and it has been sufficiently discussed by others. We now know that Dalton was thoroughly imbued with the corpuscular ideas of Newton, and that, when studying the diffusion of gases, he was led to the belief that the atoms of different substances must be different in size. Upon applying this hypothesis to chemical problems, he discovered that these differences were in one sense measurable, and that to every element a single, definite,

* 'Experiments and Observations on the Atomic Theory and Electrical Phenomena.' By William Higgins, Esq., etc., Dublin, 1814.

† *Memoirs of the Literary and Philosophical Society of Manchester*, Second Series, Volume 13, 1856.

* 'A New View of the Origin of Dalton's Atomic Theory,' etc. By Sir Henry E. Roscoe and Arthur Harden. London, 1896.

See also Debus, in *Zeits. Physikal. Chem.*, Bd. 20, p. 359, and a rejoinder by Roscoe and Harden in Bd. 22, p. 241.

combining number, the relative weight of its atom, could be assigned. From this, the law of definite proportions logically followed, for fractions of atoms were inadmissible; and the law of multiple proportions, which Dalton worked out experimentally, completed the generalization. The conception that all combination must take place in fixed proportions was not new, and, indeed, despite the objections of Berthollet, was generally assumed; but the atomic theory gave a reason for the law and made it intelligible. The idea of multiple proportions had also occurred, although incompletely, to others; but the determination of atomic weights was altogether original and novel. The new atomic theory, which figured chemical union as a juxtaposition of atoms, coordinated all of these relations, and gave to chemistry, for the first time, an absolutely general quantitative basis. The tables of Richter and Fischer, who preceded Dalton, dealt only with special cases of combination, but they established regularities which rendered easier the acceptance of the new and broader teachings. The earlier atomic speculations were all purely qualitative, and incapable of exact application to specific problems; Dalton created a working tool of extraordinary power and usefulness. Between the atom of Lucretius and the Daltonian atom the kinship is very remote.

Dalton was not a learned man, in the sense of mere erudition, but perhaps his limitations did him no harm. Too much learning is sometimes in the way, and clogs the flight of that imagination by which the greatest discoveries are made. The man who could not see the forest because of the trees was a good type of that scholarship which never rises above petty details. It may compile encyclopædias, but it can not generalize. In some ways, doubtless, Dalton was narrow, and he failed to recognize the improvements which other men soon introduced into his system. The chemical symbols which he proposed were soon supplanted by the better formulæ invented by Berzelius, and his views upon the densities of gases were set aside by the more exact work of Gay Lussac, which Dalton never fully appreciated. As an experimenter he was crude, and excelled by several of his contemporaries; his tables of atomic weights, or rather equivalents, were only rough approximations to the true values. These defects, however, are only spots upon the sun, and in no wise diminish his glory. Dalton transformed an art into science, and his influence upon chemistry was never greater than it is to-day. The truth of this statement will appear when we trace, step by step, the development of chemical doctrine. The guiding clue, from first to last, is Dalton's atomic theory.

Although Dalton first announced his theory in 1803, the publication of his 'System' in 1808 marks the culmination of his labors. The memorable controversy between Proust and Berthollet had by this time exhausted its force, and nearly all chemists were satisfied that the law of definite or constant proportions must be true. The idea of multiple proportions was also easily accepted; and as for the combining numbers, they, after various revisions, came generally into use. The atomic conception, however, made its way more slowly, for the fear of metaphysics still governed many acute minds. Davy especially was late in yielding to it, but in time even his conversion was effected. Thomson, as we have already noted, was the earliest and most enthusiastic disciple of the new system, and Wollaston, although cautiously preferring the term 'equivalent' to that of atomic weight, made useful contributions to the theory. These names mark the

childhood of the doctrine, before its vigorous growth had thoroughly begun.

The development of the atomic theory followed two distinct lines, the one chemical, the other physical, in direction. On the chemical side the leader was Berzelius, who began in 1811 the publication of his colossal researches upon definite proportions. At first he seems to have been influenced by Richter rather than by Dalton, but that bias was only temporary. For more than thirty years Berzelius continued these labors, inventing symbols, establishing formulæ and determining atomic weights. He, above all other men, made the atomic theory applicable to general use, a universal tool suited to practical purposes. Turner, Penny, Erdmann and others did noble work of the same order, but Berzelius overshadowed them all. Throughout his long career he was almost the dictator of chemistry.

It was on the physical side, however, that the theory of Dalton was most profoundly modified. First came the researches of Gay Lussac, who in 1808 showed that combination between gases always took place in simple relations by volume, and also that all gaseous densities were proportional either to the combining weights of the several substances, or to rational multiples thereof. In 1811 Avogadro generalized the new evidence, and brought forward the great law which is now known by his name. Equal volumes of gases, under like conditions of temperature and pressure, contain equal numbers of molecules. Mass and volume were thus covered by one simple expression, and both were connected with the weights of the fundamental atoms. Avogadro, moreover, distinguished clearly between atoms and molecules, a distinction which is of profound importance to chemistry, although it is not always properly appreciated by students of physics. The molecule of to-day, which is usually, but not always, a cluster of atoms, is identical with the atom of the pre-Daltonian philosophers; while the chemical unit represents a new order of divisibility which the ancients could never have imagined. A molecule of water was easily conceived by them, but its decomposition into smaller and simpler particles of oxygen and hydrogen, the chemical atoms, was far beyond the range of their knowledge. That the distinction is not always borne in mind by physicists is illustrated by the fact that in Clerk Maxwell's article 'Atom,' in the 'Encyclopædia Britannica,' Dalton is not even mentioned, and that the phenomena there selected for discussion are molecular only. Maxwell was surely not ignorant of the difference between atoms and molecules, but his knowledge had not reached the point of complete realization. His thought was of molecules, and so Maxwell unconsciously neglected the real subject of his chapter, the atom. Of late years many essays upon the atomic theory have been written from the physical side, and few of them have been free from this particular ambiguity. At first, a similar error was committed by chemists, who paid small attention to Avogadro's law, and so the latter failed to exert much influence upon chemical thought until more than forty years after its promulgation. The relation discovered by Dulong and Petit in 1819, that the specific heat of a metal was inversely proportional to its atomic weight, was more speedily accepted; but even this law did not receive its full application until many years later. To apply either of these laws to chemical theory involved a clearer discrimination between atomic weights and equivalents than was possible at the beginning. A long period of doubt and controversy was to work itself out before the full force of the physical evidence could be

appreciated. Mitscherlich's researches upon isomorphism were more fortunate, and gave immediate help in the determination of atomic weights and the settlement of formulæ. For the moment we need only note that the chemical atom was the underlying conception by means of which all these lines of testimony were to be unified.

From Dalton and Gay Lussac to Frankland and Cannizzaro was a time of fermentation, discussion and discovery. In chemistry, contrary to the saying of the preacher, there were many new things under the sun, and some of the discoveries were most suggestive. First it was found that certain groups of atoms could be transferred from compound to compound, almost as if they were veritable elements; and radicles such as ammonium, cyanogen and benzoyl were generally recognized. I say 'groups of atoms' advisedly, for as such they were regarded, and they could hardly have been interpreted otherwise. Then came the discovery of isomerism; of the fact that two substances could be strikingly different, and yet composed of the same elements in exactly the same proportions. This was only explicable upon the supposition that the atoms were differently arranged within the isomeric molecules, and it led investigators more and more to the study of chemical or molecular structure. Without the atomic theory the phenomena would have been hopelessly bewildering; with its aid they were easy to understand, and fertile in suggestions for research. Still another link in the chain of chemical reasoning was forged by Dumas, when he proved that the hydrogen of organic compounds was often replaceable, atom for atom, by chlorine. Sometimes the replacement was complete, sometimes it was only partial, and the latter cases were the most significant. In acetic acid, for example, one, two or three fourths of the hydrogen could be successively replaced, but the last fourth was permanently retained. Hydrogen, then, was combined in acetic acid in two different ways, one part yielding its place to chlorine, the other being unaffected. This behavior was soon found to be by no means exceptional; indeed, it was very common, and it opened a new line of attack upon the problems of chemical constitution. The existence of radicles, the formation of isomers, and the substitution of one element by another, were facts which strengthened the atomic theory and seemed to be incapable of reasonable interpretation upon other terms. Their connection with one another, however, was not well understood, and wearisome discussions preceded their coordination under one general law.

With the tedious controversies which distracted chemists between 1830 and 1850, we have nothing now to do; they were important in their day, but they do not come within the scope of the present argument. Theory after theory was advanced, prospered for a time, and then decayed; and chemical literature is crowded with their fossil remains. Each one, doubtless, indicated an advance in knowledge, but each one also exaggerated the importance of some special set of relations, and so overshot the mark. During this period, however, Faraday discovered the law of electrolysis which is now known by his name, and the chemical equivalents were thereby given another extension of meaning. The electrochemical theories of Berzelius had fallen to the ground, but Faraday's law came as a permanent addition to the physical side of chemistry.

During the sixth decade of the nineteenth century, two important forward steps were taken. The kinetic theory of gases gave new force to Avogadro's law, and made its complete recognition by chem-

ists necessary. Atoms, molecules, equivalents and atomic weights needed to be more sharply defined, and in this work many chemists shared. Berzelius had proposed a system of atomic weights which differed, except in the value taken for its base, but little from the one now in use. This was abandoned for a table devised by Gmelin, in which the laws of Avogadro and of Dulong and Petit were almost if not entirely ignored. Laurent and Gerhardt attempted to reform the system, but it was left for Cannizzaro, in 1858, to succeed. By doubling some of the currently accepted atomic weights, order was introduced into the prevailing chaos, and the chemical constants were brought into harmony with the physical laws. The modern atomic weights and our present chemical notation may be dated from this time, even though the preliminary anticipations of them were neither few nor inconspicuous.

The second great step forward was accomplished through the labors of several men. Frankland and Kekulé were foremost among them, but Couper, Odling, Williamson, Wurtz and Hofmann all contributed their share to the upbuilding of a new chemistry, of which the doctrine of valency was the cornerstone. A new property of the chemical atom was brought to light, and structural or rational formulæ became possible. Each atom was shown to have a fixed capacity for union with other atoms, a capacity which could be given numerical expression; and from this discovery important consequences followed. An atom of hydrogen unites with one other atom only; the atom of oxygen may combine with two; that of nitrogen with three or five; while carbon has capacity for four. All unions of atoms to atoms within a molecule are governed by conditions of this order, and the limitations thus imposed determine the possibilities of combination in a given class of compounds. In organic chemistry the conception of valency has been most fruitful, and it has shown the prophetic power which is characteristic of all good theories. It explains radicles and isomers; it predicts whole classes of compounds in advance of their actual discovery; and it has guided economic investigations from which great industries have sprung. The former partial theories regarding chemical constitution fell into their proper places under the new generalization, for that was broad enough to comprehend them all. All constitutional chemistry depends upon this property of the atoms, and any other adequate foundation for it would be difficult to find.

I have said that the discovery of valency explained the phenomena of isomerism. Indeed, it enabled chemists to foresee the existence of new isomers, and it established the conditions under which such compounds could exist. And yet, in one direction at least, its power was limited, and substances were found which the theory could not interpret. Tartaric acid, for example, exists in two modifications, differing in crystalline form and in their action upon polarized light. One acid was dextrorotatory, the other lævorotatory, while a mixture of the two in equal proportions was neutral to the polarized beam, and gave no rotation at all. Their crystals exhibited a similar difference in the arrangement of certain planes, one set being right-handed, the other left-handed; and each crystal resembled its isomer like a reflection in a mirror, alike, but reversed. For a long time this physical isomerism, as it was called, remained inexplicable, for the rules of valency gave to both molecules the same structure, and offered no hint as to the cause of the difference. Structural formulæ, however, said nothing of the arrangement of the atoms in tridimensional space, and it was

soon suspected that the root of the difficulty was here. The mere linking of the atoms with one another could be represented in a single plane, but that was obviously an imperfect symbolism.

In 1874 van't Hoff and Le Bel, working independently of each other, suggested a solution of the problem. One simple assumption was enough; merely that the quadrivalent carbon atom was essentially a tetrahedron, or, more precisely, that its four units of chemical attraction were exerted, from a common center, in the direction of four tetrahedral angles. Atoms of that kind could be built up into structures in which right-handedness and left-handedness of arrangement appeared, provided only that each one was united with four other atoms or groups all different in nature. Stereo-chemistry was born, the anomalies vanished, and many new substances showing optical and crystalline properties analogous to those of tartaric acid were soon prepared. The theory of van't Hoff and Le Bel was fertile, and therefore it was justified; it interpreted another set of phenomena, but, in order to do so, something like atomic form had first to be assumed. It was only a new extension of Dalton's atomic theory, but it has suggested a future development of extraordinary significance. If we can determine, not merely the linking of the atoms, but also their arrangement in space, we should be able, sooner or later, to establish a connection between chemical composition and crystalline form. The architecture of the molecule and the architecture of the crystal must surely, in some way, be related. But the problem is exceedingly complex, and we may have to wait many years before we reach its solution. The atomic theory still has room to grow.

Let us now turn back in time, and consider another phase of our subject. In 1815 Prout suggested that the atomic weights of all the elements were even multiples of that of hydrogen. It was only a speculation on the part of Prout, and yet it led to important consequences, for it opened a discussion upon the nature of the chemical elements, and it pointed to hydrogen as the primal matter of the universe. Prout's hypothesis, therefore, became a subject of controversy; it found many supporters and also many antagonists; but, fortunately, one aspect of it was capable of experimental investigation. Some of the most exact and elaborate determinations of atomic weight have been made with the direct purpose of testing the truth or falsity of Prout's speculation, and science thereby has been notably enriched. The marvelous researches of Stas, for instance, had this specific object in view. The verdict was finally unfavorable to Prout; at least, the best measurements fail to support his idea; but it still has advocates who believe that the experimental data are vitiated by unknown errors and that future investigations will reverse the decision. In science there is no court of last appeal.

Prout's hypothesis, then, stimulated the determination of atomic weights, and so helped us to a more accurate knowledge of them. It also led to a search for other relations between these constants, and thus paved the way for important discoveries. Döbereiner, Kremers, Dumas, Pettenkofer, Cooke and many other chemists published memoirs upon this theme, but not one of them was general or conclusive.* Groups of elements were compared and relations were brought to light, but an exhaustive study of the question was hardly possible until after Cannizzaro had revised the

* A very full account of these attempts is given in Venable's book, 'The Development of the Periodic Law.' Published at Easton, Pennsylvania, in 1896.

atomic weights and indicated their proper values.

In 1865, Newlands presented before the London Chemical Society a communication upon the law of octaves, in which he showed that the elements, when arranged in the order of their atomic weights, exhibited a certain regular recurrence of properties. Unfortunately, his views were not given serious attention, and even met with ridicule, but they contained the germ of the great truth. It was reserved for the Russian, Mendeléeff, four years later, to completely formulate the famous periodic law.

Mendeléeff arranged the elements in tabular form, still following the order of their atomic weights. A periodic variation of their properties, including the property of valency, at once became evident; and although the scheme was, and still is, open to some criticism, its importance could hardly be denied. In the table, certain gaps appeared, presumably belonging to unknown elements, and for three of these some remarkable predictions were made. The hypothetical elements were described by Mendeléeff, their atomic weights were assigned and their physical properties foretold, and in due time the prophecies were verified. The three metals gallium, scandium and germanium have since been discovered, and they correspond very closely with Mendeléeff's anticipations. His general conclusion was that all of the physical properties of the chemical elements are periodic functions of their atomic weights, and this conclusion, I think, is no longer seriously doubted. The curves of atomic volumes and melting points which Lothar Meyer afterwards constructed give strong support to this view.

The periodic system, then, gives to the numbers discovered by Dalton a much more profound significance than he ever imagined, and is destined to connect a great mass of physical data in one general law. That law we now see, 'as in a glass, darkly'; its complete mathematical expression is yet to be found, but I believe that it will be fully developed within the near future. We may have a spiral curve to deal with, as in the schemes proposed by Stoney or by Crookes, or else a vibratory expression like that suggested by Emerson Reynolds in his presidential address before the Chemical Society last year; but in some form the periodicity of the elements must be recognized, and one set of relations will connect them all. In the arrangement proposed by Reynolds the inert gases, the elements of zero valency, appear at the nodes of a vibrating curve, a circumstance which gives this method of presentation a peculiar force. But for the consideration of physical properties the curves drawn by Lothar Meyer seem likely to be the most useful. In one respect, however, the periodic system is still defective; it fails to take adequately into account the numerical relations between the atomic weights, a phase of the problem which should not be ignored. Such relations exist; some of them have been indicated by your distinguished fellow member, Dr. Wilde; and, elusive as they may seem to be, they are surely not meaningless. The final law must cover the entire ground, and then atomic weights, physical properties and valency will be completely correlated. Prout's hypothesis is discredited, and yet it may prove to be a crude first approximation to some deeper truth, as the probability calculations of Mallet* and of Strutt† would seem to indicate. The approaches of the atomic weights to whole numbers are too close and too frequent to be regarded as purely accidental. But this is aside from

* *Phil. Trans.*, Vol. 171, 1881, p. 1003.

† *Phil. Mag.* (6), 1, p. 311.

our main question. The real point to note is that the physical properties of the elements are all interdependent, and that the fundamental constants are the atomic masses.

Do I seem to exaggerate? Then look for a moment at the present condition of physical chemistry, and see how moderate my statements really are. We have not only the laws already mentioned, of Avogadro, of Dulong and Petit, of Faraday and of Mendeléeff, but also a multitude of relations connecting the physical constants of bodies with their chemical character. Even the wave-lengths of the spectral lines are related to the atomic weights of the several elements, as has been shown by the researches of Runge and his colleagues, of Rummel,* and of Marshall Watts.† If we try to study the specific gravity of solids or liquids, the only clues to regularity are furnished by the atomic ratios. Atomic and molecular volumes give us the only approximations to anything like order. Similarly, we speak of atomic and molecular refraction, of molecular rotation for polarized light, of molecular conductivity and the like. In Trouton's law, the latent heat of vaporization of any liquid becomes a function of the molecular weight. And, finally, all thermochemical measurements are meaningless until they have been stated in terms of gram molecular weights; then system begins to appear. Chaos rules until the atomic or molecular weight is taken into account; with that considered, the reign of order begins.

Even to the study of solutions the same conditions apply. Substances in solution exert pressure, and in this respect they closely resemble gases. Van't Hoff has shown that equal volumes of solutions, having under like conditions equal osmotic pressures, contain equal numbers of molecules, and thus Avogadro's gas law is curiously paralleled. The two laws are even equivalent in their anomalies. The abnormal density of a gas is explained by its dissociation, and the variations from van't Hoff's law are explicable in the same way. The theory of ionic or electrolytic dissociation, proposed by Arrhenius, shows that certain substances, when dissolved, are split up into their ions, and through this conception the analogy between gases and solutions is made absolutely complete. The ions, however, are atoms or groups of atoms; and just as Avogadro's law is applied to the determination of molecular weights among gases, so van't Hoff's rules enable us to measure the molecular weights of substances in solution. The atom, the molecule, and the molecular weight enter into all of these new generalizations. In short, if we take the atomic theory out of chemistry, we shall have little left but a dust-heap of unrelated facts.

I have now indicated, briefly and in outline only, the influence of the atomic theory upon the development of chemical thought. Details have been purposely omitted; the salient facts are enough for my purpose, and they make, at least for chemists, an exceedingly strong case. The convergence of the testimony is remarkable, and when we add to the chemical evidence that which is offered by physics, the theory becomes overwhelmingly strong. This side of the question I can not attempt to discuss, but I may in passing just refer to Professor Rücker's presidential address before the British Association in 1901, which covers the ground admirably. The atomic theory has had no better vindication.

And yet, from time to time, we are told that the theory has outlived its usefulness, and that it is now a hindrance rather than a help to science. Some of the objectors

* *Proc. Roy. Soc. Victoria*, Vol. 10, part I., p. 75.

† *Phil. Mag.* (6), 5, 203.

are quite dogmatic in their utterances; some only seek to evade the theory, without going to the extreme of an absolute denial; and still others, more timid, assume an apologetic tone, as if the atom were something like a poor relation, to be recognized and tolerated, but not to be encouraged too far. Now caution is a good thing, if it is not allowed to degenerate into indecision; when that happens, mental obscurity is the result. In science we must have intellectual resting-places; something to serve as a foundation for our thinking; something concrete and tangible in form. No theory is immune against hypercriticism; none is absolute and final; with these considerations borne in mind we may ask whether a doctrine is serviceable or not, and we can use it without fear. When we say that matter, as we know it, behaves as if it were made up of very small, discrete particles, we do not lose ourselves in metaphysics, and we have a definite conception which can be applied to the correlation of evidence and the solution of problems. Objections count for nothing against it until something better is offered in its stead, a condition which the critics of the atomic theory have so far failed to fulfil. They give us no real substitute for it, no other working tool, and so their objections, which are too often metaphysical in character, command little serious attention. Criticism is useful, just so far as it helps to clarify our thinking; when it becomes a mere agent of destruction it loses force.

Broadly speaking, then, the modern critics of the atomic theory have shaken it but little. Still, some serious attempts have been made towards forming an alternative system of chemistry, or at least a system in which the atom shall not avowedly appear. The most serious, and perhaps the most elaborate of these devices was that brought forward in 1866 by Sir Benjamin Brodie,* in his 'Calculus of Chemical Operations,' which he defended later (1880) in a little book entitled 'Ideal Chemistry.' In this curious investigation, Brodie tries to avoid hypotheses and to represent chemical acts as operations upon the unit of space by which weights are generated. This notion is a little difficult to grasp, but Brodie's procedure was perfectly legitimate. His one fundamental assumption is that hydrogen is so generated by a single operation, and upon this he erects a system of symbols which, treated mathematically, lead to some remarkable conclusions. For instance, chlorine, bromine, iodine, nitrogen and phosphorus become compounds of hydrogen with as many unknown or 'ideal' elements, which no actual analysis has yet identified. That is, the known phenomena of chemistry seem to be less simply interpreted by Brodie's calculus than in our commonly accepted theories, and certain classes of phenomena are not considered at all. It is true that Brodie never completed his work, but it is not easy to see how his notation and reasoning could have accounted for isomerism, much less for the facts which stereochemistry seeks to explain.

Just here we find the prime difficulty of all attempts to evade the atomic theory. Up to a certain point we can easily dispense with it, for we can start with the fact that every element has a definite combining number, and then, without any assumptions as to the ultimate meaning of these constants, we can show that other constants are intimately connected with them. So far, we can ignore the origin of the so-called atomic weight; but the moment we encounter the facts of isomerism or chemical structure, and of the partial substitution of one element by another, our troubles

* *Phil. Trans.*, 1866. A second part in 1877.

begin. The atomic theory connects all of these data together, and gives the mind a simple reason for the relations which are observed. We can not be satisfied with mere equations; our thought will seek for that which lies behind them; and so the anti-theorist fails to accomplish his purpose because he leaves the human mind out of account. The reasoning instrument has its own laws and requirements, and they, as well as the empirical observations of science, must be satisfied. Even in astronomy the law of gravitation is not enough; men are continually striving to ascertain its cause; and no number of failures can prevent them from trying again and yet again to penetrate into the heart of the mystery. In the atomic theory the same tendency is at work, and the very nature of the atom itself, that thing which we can neither see nor handle, has become a legitimate subject for our questionings. Shall we, having gone so far, assume that we can go no farther?

'All roads lead to Rome.' If we accept the atomic theory, we sooner or later find ourselves speculating about the reality of the atom, and at last we come face to face with the old, old problem of the unity or diversity of matter. We can, if we choose, employ the theory as a working tool only, and shut our ears to these profounder questions; but it is not easy to do so. What is the chemical atom? Is all matter ultimately one substance? We may be unable to solve either problem, and yet we can examine the evidence and see which way it points.

I think that all philosophical chemists are now of the belief that the elements are not absolutely distinct and separate entities. In favor of their elementary nature we have only negative evidence, the mere fact that with our present resources we are unable to decompose them into simpler forms. On that side of the argument there is nothing more. On the other hand, we see that the elements are bound together by the most intimate relations, so much so that unknown elements can be accurately described in advance of their discovery, and facts like these call for an explanation. Something belonging to the elements in common seems to underlie them all. If, however, we study the atomic weights, we are forced to observe that the elements do not shade into one another continuously, but that they vary by leaps which are sometimes relatively large, and sometimes quite small. To Mendeléeff this irregular discontinuity is an argument against the unity of matter, or, rather, an indication that the periodic law lends no support to the belief; but such a conclusion is unnecessary. If the fundamental matter, the 'protyle,' as Crookes has called it, is itself discontinuous and atomic in structure, the same property must be shown in all of its aggregations, and so the difficulties seen by Mendeléeff disappear. The chemical atoms become clusters of smaller particles, whose relative magnitudes are as yet unknown.

That bodies smaller than atoms really exist is the conclusion reached by J. J. Thomson* from his researches upon the ionization of gases. According to him, this phenomenon 'consists in the detachment from the atom of a negative ion,' this being 'the same for all gases.' He regards 'the atom as containing a large number of smaller bodies,' which he calls 'corpuscles,' and these are equal to one another. "In the normal atom this assemblage of corpuscles forms a system which is electrically neutral." It must be borne in mind that these conclusions are drawn by Thomson from the study of one class of phenomena,

* *Phil. Mag.* (5), 48, p. 547. Also *Popular Science Monthly*, August, 1901.

and it is of course possible that they may not be finally sustained. Their value to us at the present moment lies in their suggestiveness, and in the curious way in which they reinforce other arguments of similar purport. The possibility that the chemical atoms can be actually broken down into smaller particles of one and the same kind, is, to say the least, startling, but it can not be disregarded. The evidence obtained by Thomson is, so far as it goes, positive, and it is entitled to receive due weight in all discussions of our present problem. It is the first *direct* testimony that we have been able to obtain, all previous evidence being either negative or circumstantial. It may be misinterpreted, but it is not to be pushed aside.

In direct line with the inferences of Thomson are the results obtained by Rutherford and Soddy in their researches upon radio-activity. Here, again, we have a subject so new that all opinions concerning it must be held open to revision, but, so far as we have yet gone, the evidence seems to point in one way. Rutherford and Soddy* have studied especially the emanations given off by thorium, and conclude that from this element a new body is continually generated, in which the radioactivity steadily decays. This loss of emanative power is in some sort of equilibrium with the rate of its formation. When thorium is 'de-emanated,' it slowly regains its emanative power. The emanation is a 'chemically inert gas, analogous in nature to the members of the argon family.' The final conclusion is that radio-activity may be 'considered as a manifestation of subatomic chemical change.' This word 'subatomic' is one of ominous import. It implies atomic complexity, and it also suggests something more. The property of radio-activity is most strikingly exhibited by the metals radium, thorium and uranium; and these have the highest atomic weights of any elements known. If the elements are complex, these are the most complex, and therefore, presumably, the most unstable. Are they in the act of breaking down? Is there a degradation of matter comparable with the dissipation of energy? We can ask these questions, but we may have to wait long for a reply. There is, however, another side to the shield, and the universe gives us glimpses of a generative process, an elementary evolution.

* *Phil. Mag.* (6), 4, pp. 395 and 581.

The truth or falsity of the nebular hypothesis is still an open question. It is a plausible hypothesis, however, and commands many strong arguments in its favor. We can see the nebulæ, and prove them to be clouds of incandescent gas; we can trace a progressive development of suns and systems, and at the end of the series we have the habitable planet upon which we dwell. The nebular hypothesis accounts for the observed condition of things, and is therefore, by most men, regarded as satisfactory. But this is not all of the story. Chemically speaking, the nebulæ are exceedingly simple in composition; the whiter and hotter stars are a little more complex; then come stars like our sun and finally the finished planets with their many chemical elements and their myriads of compounds. Here again we have evidence bearing upon our problem, evidence which led me,* more than thirty years ago, to suggest that the evolution of planets from nebulæ had been accompanied by an evolution of the elements themselves. This thought, stated in a reversed form, has since been developed and amplified by Lockyer, and it is doubtless familiar to you all. In the development of the heavenly bodies we seem to see the

* 'Evolution and the Spectroscope,' *Popular Science Monthly*, January, 1873.

growth of the elements; do we, in the phenomena of radio-activity, witness their decay? This is a startling, possibly a rash speculation, but it rests upon evidence which must be considered and weighed.

We have, then, various lines of convergent testimony, and there are more which I might have cited, all pointing to the conclusion that the chemical atoms are complex, and that elemental matter, in the last analysis, is not of many kinds. That there is but one fundamental substance, is not proved; and yet the probability in favor of such an assumption must be conceded. Assuming it to be true, what then is the nature of the Daltonian atom?

To the chemist, the simplest answer to this question is that furnished by the researches of J. J. Thomson, to which reference has already been made. A cluster of smaller particles or corpuscles satisfies the conditions that chemistry imposes on the problem, their ultimate nature being left out of account. For chemical purposes we need not inquire whether the corpuscles are divisible or indivisible, although for other lines of investigation this question may be pertinent. But no matter how far we may push our analysis, we must always see that something still lies beyond us, and realize that nature has no assignable boundaries. That which philosophers call 'the absolute' or 'the unconditioned' is forever out of our reach.

Through many theories men have sought to get back a little farther. Among these, Lord Kelvin's theory of vortex atoms is perhaps the most conspicuous, and certainly the best known. It presupposes an ideal perfect fluid, continuous, homogeneous and incompressible; portions of this in rotation form the vortex rings, which, when once set in motion by some creative power, move on indestructibly forever. These rings may be single, or linked or knotted together, and they are the material atoms. The assumed permanence of the atom is thus accounted for and given at least a mathematical validity, but we have already seen that the chemical units may not be quite so simple. The ultimate corpuscles, to use J. J. Thomson's words, may be vortex rings; the chemical atom is much more complex. On this theory, chemical union has been explained by supposing that vortices are assembled in rotation about one another, forming groups which are permanent under certain conditions and yet are capable of being broken down. The vortex ring is eternal, its groupings are transitory. This is a plausible and fascinating theory; if only we can imagine the ideal perfect fluid and apply to it the laws of motion; that done, all else follows. Unfortunately, however, the fundamental conception is difficult to grasp and still more difficult to apply. So far, it has done little or nothing for chemistry; it has brought forth no discoveries, nor stimulated chemical research; we can only say that it does not seem to be incompatible with what we think we know. In a certain way it unifies the two opposing conceptions of atomism and plenism, and this may be, after all, its chief merit.

But there are later theories than that of Kelvin, and some of them are most daring. For instance, Professor Larmor regards electricity as atomic in its nature, and supposes that there are two kinds of atoms, positive and negative electrons. These electrons are regarded as centers of strain in the ether, and matter is thought to consist of clusters of electrons in orbital motion round one another. Still more recently, Professor Osborne Reynolds, in his Rede lecture,* has offered us an even more

* 'On an Inversion of Ideas as to the Structure of the Universe.' Cambridge, 1903. The Rede Lecture, delivered June 10, 1902.

startling solution of our problem. He replaces the conventional ether by a granular medium, generally homogeneous, closely packed, and having a density ten thousand times that of water. Here and there the medium is strained, producing what Reynolds calls 'singular surfaces of misfit' between the normally piled grains and their partially displaced neighbors. These surfaces are wave-like in character, and constitute what we recognize as ordinary matter. Where they exist there is a local deficiency of mass, so that matter is less dense than its surroundings; and this, as Reynolds has said, is a complete inversion of the ideas which we now hold. Matter is measured by the absence of the mass which is needed to complete a normal piling of the grains in the medium. In other words, it might be defined as the defect of the universe. The 'singular surfaces' already mentioned are molecules, which may cohere, but can not pass through one another, and they preserve their individuality. Possibly I may misapprehend this theory, for it has been published in a most concise form, and the reasoning upon which it rests is not given in detail. I can not criticize it, but I may offer some suggestions. If matter consists of waves in a universal medium, how does chemical union take place? Shall we conceive of hydrogen as represented by one set of waves and nitrogen as represented by another, the two differing only in amplitude? If so, when they combine to form ammonia there should be either a superposition of one set upon the other, or else a complex system might be found showing interference phenomena. But would not the latter supposition imply a destruction of matter as matter is defined by theory? Could one such wave coalesce with or neutralize another? To conceive of a union of waves without interference is not easy, but the facts of chemical combination must be taken into account. When we remember that compounds exist containing hundreds of atoms within the molecule, we begin to realize the difficulties which a complete theory of matter must overcome. Chemical and physical evidence must be taken together; neither can solve the problem alone. At present, the simplest conception for the mind to grasp is that of an aggregation of particles. Beyond this all is confusion, and mathematical devices can help us only a little. In speaking thus I assign no limit to the revelations of the future; some theory, now before the world, may prove its right to existence and survive; but none such, as yet, can be taken as definitely established. The theory which stands the test of time will not be a figment of the imagination; it must be an expression of observed realities. But enough of speculation; let me, before I close, say a few words of a more practical character.

Dalton's statue stands in Manchester, a fitting tribute to his fame. But it is something which is finished, something on which no more can be done, something to be seen only by the few. As a local memorial it serves a worthy purpose, but Dalton's true monument is in the set of constants which he discovered, and which are in daily use by all chemists throughout the world. Here is something that is not finished; and here Dalton's memory can be still further honored, by good work, good research, honest efforts to increase our knowledge. We have seen that the atomic weights are the fundamental constants of all exact chemistry, and that they are almost as important also to physics; but the mathematical law which must connect them is still unknown. Every discovery along the line of Dalton's theory is another stone added to his monument, and many such discoveries are yet to be made.

What, now, is needed? First, every

atomic weight should be determined with the utmost accuracy, and what Stas did for a few elements ought to be done for all. This work has more than theoretical significance; its practical bearings are many, but it cannot be done to the best advantage along established lines. So far the investigators have been a mob of individuals; they need to be organized into an army. Collective work, cooperative research, is now demanded, and the men who have hitherto toiled separately should learn to pull together. Ten men, working on a common plan, in touch with one another, can accomplish more in a given time than a hundred solitaries. The principles at issue are well understood; the methods of research are well established; but the organizing power has not yet appeared. Shall this be a great institution for research, able to take up the problems which are too large for individuals to handle, or a voluntary cooperation between men who are unselfishly inclined to attempt the work? This question I can not answer; doubtless it will solve itself in time; but I am sure that a method of collective investigation will be found sooner or later, and that then the advance of exact knowledge will be more rapid than ever before. When the atomic weights are all accurately known, the problem of the nature of the elements will be near its solution. Some of the wealth which chemistry has created might well be expended for this purpose. Who will establish a Dalton laboratory for research, and so give the work which he started a permanent home?

F. W. CLARKE.

SCIENTIFIC BOOKS.

British Museum (Natural History); First Report on Economic Zoology. By FRED. V. THEOBALD, M.A.

This is a volume of xxxiv–192 pages, with 18 illustrations, consisting primarily of a series of reports to the Board of Agriculture, of reports and letters to a variety of unofficial correspondents, and of reports to the Foreign Office and the Colonial Office, drawn up by Mr. Theobald during the years 1901–1902. Mr. Theobald has recently been employed by the trustees of the British Museum to assist the director in such work, especially with a view of furnishing the Board of Agriculture with scientific information on Economic Zoology, in accordance with a request made by that department of His Majesty's government.

As may be supposed, the subjects treated have come from all parts of the British Empire and are of more than local interest. The insects mentioned, having especial interest for the American entomologist, are the pear midge, *Diplosis pyrivora* Riley; the mussel scale, *Mytilaspis pomorum;* the apple aphis, *Aphis mali;* the tarnished plant bug, *Lygus pratensis,* attacking chrysanthemums; *Dermestes lardaris;* the bud moth, *Hedya ocellana;* the pear-leaf blister mite, *Eriophyes pyri;* and the Colorado potato beetle which made its appearance in England in 1901 and again in 1902. This last pest appeared in Tilbury dockyard on potato plants on the workmen's allotments. The land was cleared of all potato hulm and the hulm burned with paraffin, at night, on the ground and under the supervision of an officer of the Board of Agriculture; the ground soaked with paraffin, and plowed ten inches deep, after which it was dressed with gas lime, 60 tons per acre. Despite this treatment a few beetles appeared in 1902, but these were promptly collected and destroyed.

While not comparing with the classical reports of the late Miss Ormerod, from an entomological point of view, this is England's first attempt at providing for an official entomologist, and it is to be hoped that it may prove a beginning that will expand until the mother country will no longer continue to be outdone by even her smallest colonies, like Tasmania, Cape Colony and Natal, for illustration. Mr. Theobald might well be wholly employed in this work, and his first report is a good indication that he would prove a most

capable and efficient officer, if he were afforded the proper facilities for carrying out the proper functions of Government Entomologist.

F. M. Webster.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for September begins with 'A Contribution to the Morphology and Development of *Corymorpha pendula* Ag' by Albert J. May. This includes a study of the origin of the sex cells and of the phenomena associated with oögenesis. J. Arthur Harris has a paper on 'The Habits of *Cambarus*' which contains many interesting observations on the burrowing habits of some species and their 'chimney building.' Max Morse contributes the nineteenth of the 'Synopses of North American Invertebrates,' this being devoted to the Trichodictidæ, forming a monograph of the North American species. The balance of the number comprises reviews and notes, the botanical notes being many in number.

With the October issue *The American Museum Journal* begins its appearance as a quarterly. The number is practically devoted to an account of 'The Jesup North Pacific Expedition' accompanied by maps and illustrations. The supplement forms 'Guide Leaflet No. 12,' and in its thirty-two pages W. D. Matthew describes 'The Collection of Fossil Vertebrates' which has recently been rearranged. This Leaflet contains many illustrations and a large amount of information; it should be in great demand by others than museum visitors.

SOCIETIES AND ACADEMIES.

ONONDAGA ACADEMY OF SCIENCE.

The first meeting of the Academy since the summer vacation was called to order by the president, Dr. Kraus, in the rooms of the Historical Society in Syracuse on September 25, 1903. P. F. Schneider presented a paper on 'Mica Prospects in Northern Georgia.' He gave a description of the area in which the mica occurs, of the mica-feldspar, pegmatite dikes in which it occurs, and considered the conditions favoring the further development, such as the water power, cost of labor, etc. He closed with a statement of the different uses of mica. Mica has been produced in limited quantities in northern Georgia in years past and Mr. Schneider concludes that the surface indications justify further development and an increased output.

T. C. Hopkins,
Corresponding Secretary.

DISCUSSION AND CORRESPONDENCE.

THE ANIMAL PARASITE SUPPOSED TO BE THE CAUSE OF YELLOW FEVER.

My connection with the Working Party No. 1 of the Yellow Fever Institute and the basis on which I rest my claim as being the *first to have interpreted correctly and given value to the things found in the bodies of the mosquitoes infected from yellow fever patients.*

Working Party No. 1 of the Yellow Fever Institute (a bureau of the U. S. Marine Hospital Service), consisting of Dr. Herman B. Parker, P.A., surgeon and chairman, Washington, D. C., Professor G. E. Beyer, biologist at Tulane University, and Dr. O. L. Pothier, pathologist, Charity Hospital, New Orleans, reports in Bulletin No. 13 of the Institute the results of its labors in Vera Cruz during the summer of 1902.

Section 6 of this bulletin contains the description of an animal parasite which was found in the bodies of mosquitoes infected from yellow fever patients.

In the letter of transmittal the following sentence occurs:

> In the proper study and classification of this new parasite the Working Party desires to express its thanks to Mr. J. C. Smith, of New Orleans, La., for valuable aid and suggestions in working out the life-history of the organism.

I claim that the above recognition is not commensurate with the services I rendered to the party. That it was not 'aid and suggestions' that the party received from me, but that it was given the pith of the whole matter included in the section entitled: 'The Contaminated *Stegomyia fasciata* and its Parasite,' as I will show further on.

The members of the party had all returned from Vera Cruz about October 1, 1902.

Professor Beyer had solicited, a number of times, my assistance in working up the material he had prepared, consisting of slides of infected mosquitoes.

On January 23, 1903—*fifteen weeks after the return* of the members from Mexico—I undertook the examination of their material. Up to this time, Professor Beyer, who was the biologist of the party, knew of no evidence of a parasite in these mosquitoes excepting some 'granular bodies,' as they were styled, which were found in the cells of the salivary glands, and which I afterwards showed the party were not 'granular bodies,' but were *linear* bodies, five or six times longer than wide—the sporozoites.

On January 30 I reported having found in the bodies of a number of the mosquitoes an animal parasite in process of sexual development. This report was accompanied by my sketch of all the processes.

According to Professor Beyer's statement to me at the time, Dr. Parker was urged to come to New Orleans in order to see the results of my investigations. The party was then ordered to convene in New Orleans. Dr. Parker arrived on or about the tenth of February, and a very short time after his arrival he and Professor Beyer called on me. They were both shown my sketch of the parasite in its various stages and given by me a history of these stages. Dr. Parker thanked me for my services and expressed his desire to see the parasite. He examined the sketch very carefully and did not say that he had ever recognized any of the stages depicted in the sketch.

On or about February 12 the members had their first session and heard my report read. At this session and the two following I was present, and, singly and alone, demonstrated step by step the parasite and its gradual development from the third to the fifteenth day after infection.

On showing the spores in the tissues surrounding the salivary glands (wandering spores), Dr. Parker remarked that he had a photograph showing this phase. He then opened a package of well-executed photographs which he had brought from Washington, and found one showing these spores. There were about fifteen photographs in the package and after all had been examined carefully *no trace of any other phase of the parasite could be found.* As Dr. Parker knew the object of his coming to New Orleans, it is perfectly natural to conclude *that if he had had any other photographs showing the parasite, he would have brought them with him.*

At no time during these sessions did any member of the party signify by word or action that any of the phases which were being shown them had been seen before. On the contrary, the difficulty which I had in getting them to see and comprehend some of the phases was conclusive evidence that they were seeing these things for the first time.

At the conclusion of the third session I said to the members that I expected to be given full recognition for my services and this recognition must be placed *in the text treating on the parasite,* and not in the letter of transmittal.

Dr. Parker, speaking for and before the members, again thanked me for my work and promised that I should be given the recognition asked, and that it would be placed in the text treating the parasite.

At the fourth and final session—to which I was not invited and did not attend—the history of the parasite was incorporated in the final report of the working party. Dr. Parker and Professor Beyer had written this history so that it was a copy of my report, to which Dr. Pothier objected and advised that it be written in their own way so as not to appear as a duplicate of my report. This advice prevailed and the history was written as it now appears in Bulletin No. 13.

At this session Dr. Parker and Professor Beyer, notwithstanding their promise to me the day before, declined to recognize my services. Dr. Pothier was indignant and refused to sign the report unless justice were done me. A recognition was then placed *in the text treating of the parasite* and the report was signed by the three members. On the return of Dr. Parker to Washington this recognition *was suppressed,* as will be shown

further on by Surgeon-General Wyman's letter to me dated August 24.

All that I have related above concerning the four sessions can be corroborated by Dr. O. L. Pothier, who was a member of the working party and attended the sessions.

Some days after this fourth session I tried to learn from Professor Beyer what had been done in the matter of recognition of my services, but could get no satisfactory answer from him. I then told him that I intended to criticize the report when it was published, and that the party had failed to get one very important characteristic of the parasite. That characteristic is that all the gametes have a non-contractile vacuole in their anterior halves. If the reader will look over the report, he will find that this very important feature is not mentioned.

Several days after this interview with Professor Beyer, I received the following letter from Dr. Parker:

TREASURY DEPARTMENT,
MARINE-HOSPITAL SERVICE,
WASHINGTON, D. C., Mch. 6, 1903.

MR. J. C. SMITH,
New Orleans, La.

My Dear Mr. Smith: Since returning to Washington I have been intending to write to you and ask if you will transmit to me at your earliest convenience your opinion of the organism and its phases as you saw them with Dr. Beyer.

I would like this not only for my own information, but if necessary to quote you on points that at present may seem somewhat hazy.

The subject is, as you know, a rather large one, especially for those who are not familiar with more than the rudiments of this branch of the sciences. *I hope, however, to acquire enough from my friends and the books to make this organism presentable.*

Very truly yours,
(Signed) HERMAN B. PARKER,
Passed Assistant Surgeon.

(The italics are mine.)

To which the following reply was sent:

NEW ORLEANS, LA.,
March 10, 1903.

DR. HERMAN B. PARKER,
P. A. SURG. MARINE-HOSPITAL SERVICE,
WASHINGTON, D. C.

My Dear Dr. Parker: Yours of the 6th inst. to hand and from its contents I conclude something has gone wrong * * * . It seems to me that I am not going to receive from your commission (working party), the recognition which I justly claim, so I have concluded to *reserve what I have to say about the parasite and the part I have taken to bring it to light until the report is published.* If I am mistaken as to the treatment your commission (working party) contemplates according me, I shall say no more about it, but *you* will have to assure me of my mistake and say just *how* I am to be recognized before I can feel satisfied to give you my written views as you request in your letter of the 6th inst.

Yours truly,
(Signed) J. C. SMITH.

To which no reply has been received.

On May 6, during the session of the American Medical Association in New Orleans, I had a conference with Surgeon-General Wyman. At this conference I related the story of my connection with the working party, which was substantially as it is written above, and said to him that I had good reasons to believe that I was not to receive the recognition I was entitled to. In response to his question as to what recognition I wanted, I handed him the following memorandum:

The commission is indebted to Mr. J. C. Smith, of New Orleans, La., for his valuable services in working out the sexual life-history of the parasite in the body of the mosquito.

This to be in the text treating on the parasite.

He said that was the first time he had heard of my connection with the working party; that the party had no right to go outside the department for assistance; that he would investigate the matter and would do justice to me.

On June 10 Dr. Wertenbaker, surgeon at the Marine Hospital in New Orleans, called on me and presented a telegram from Surgeon-General Walter Wyman which read as follows:

See J. C. Smith and get from him a signed statement of his relation to the working party and his understanding as to recognition.

On the same day Dr. Wertenbaker was given the signed statement, which contained the same items recorded above, and the fol-

lowing as 'my understanding as to recognition':

The commission is indebted to Mr. J. C. Smith, of New Orleans, La., for his valuable services in working out the sexual life-history of the parasite in the body of the mosquito.

This to be in the text treating on the parasite.

On the same date as above Dr. Wertenbaker presented a somewhat similar telegram from Surgeon-General Wyman to Dr. O. L. Pothier, whose reply was as follows:

NEW ORLEANS, June 10, 1903.

DR. WERTENBAKER,
SURGEON P. H. & M. H. SERVICE,
NEW ORLEANS, LA.

Dear Sir: In compliance with the request made through you by Surgeon-General Wyman, I wish to make the following statement:

First. When I signed the report it contained what I believed to be full recognition of the work done by Mr. J. C. Smith.

Second. The paragraph embodying this read as follows: In the proper study and classification of this new parasite the working party desires to express its thanks to Mr. J. C. Smith for valuable aid and suggestion in working out the life-history of the organism. After the words 'J. C. Smith,' it was agreed that the words 'for the demonstration and' should be embodied, but I find that these words have been left out in my copy of the report.

Third. I positively refused to sign the report unless recognition was given Mr. J. C. Smith.

As to other relevant data, I may say that Mr. J. C. Smith was present at all the meetings of the commission here in New Orleans, except the meeting preceding the signature of the report. At this meeting the discussion of the report came up and it was that night that I refused to sign the report unless Mr. Smith was given recognition, and it was the only consideration which induced me to sign the report.

We had seen, while still in Vera Cruz, two phases of the organism described in the report, one phase proved to be what is described further as the wandering spores of the parasites and the other bodies in the salivary glands, but it was not until Mr. J. C. Smith had been called by Professor Beyer, without authorization of any of the working party, so far as I know, that the whole life cycle of the organism was demonstrated.

And at the meetings of the commission here in New Orleans, Mr. Smith fully demonstrated the life cycle of the parasite.

I am fully convinced that had he not done so at the time, that the parasite would not have been demonstrated by the commission, as none of us could at that time find the different phases of the cycle without the help of Mr. Smith.

It was on this account that I refused to sign the report as no mention of Mr. Smith was made, and as I said above it was conditional on the embodiment of this recognition that I consented to sign the report. This paragraph should read as the original was intended as follows:

"In the proper study and classification of this new parasite the working party desires to express its thanks to Mr. J. C. Smith for the demonstration, and for valuable aid and suggestions in working out the life-history of the organism."

Further, I would state that it was agreed that the galley sheets were to be sent to each one of the party for correction and approval. This latter agreement was not carried out, and I have not seen proofs of the report up to this date.

In closing, I wish to state that two or three days before the receipt of the telegram convening the commission here in New Orleans, Mr. Smith sent me a full diagram of the life-cycle of the organism in question.

I think I have given all the information that I possess on this subject and hope that it may prove satisfactory.

Yours truly,
(Signed) O. L. POTHIER, M.D.

The report of the working party is dated New Orleans, February 17, 1903, but was not issued until about the fifteenth of July, at which time a copy came to my hands. Not being satisfied with the recognition in the report, nor with its position, I addressed a protest to Surgeon-General Wyman as follows:

NEW ORLEANS, August 17, 1903.

GENERAL WALTER WYMAN,
WASHINGTON, D. C.

My Dear Sir: I regret very much the necessity of entering my protest against the style and position of the recognition of my services which the Working Party No. 1 of your Yellow Fever Institute has accorded me. My request, as I had given it to you upon your solicitation, was for 'valuable services in working out the sexual life-history of the parasite in the body of the mosquito'—'this to be in the text treating on the parasite.'

In the report of the working party, recently issued, I find I am thanked for 'valuable aid and

suggestions in working out the life-history of the organism,' which may be construed as meaning very little, and this is placed in the letter of transmittal, where I consider it is buried.

When I gave into your possession the evidences on which I based my claim to recognition, you made no mention of any existing evidence that might tend to modify my claim. If any evidence came to your knowledge since our conference last May which led you to consider that I was claiming too much, I maintain that it was your duty, before taking final action, to notify me of this evidence and of its nature, in order to afford me the opportunity of rebutting it, if possible. As you have not done so, but have modified my recognition very radically, you have left but one channel open for me to obtain proper recognition for my services, and that is to appeal to the fair judgment of the scientific world.

Yours truly,
(Signed) J. C. Smith.

To which the following reply was received:

Treasury Department,
Bureau of Public Health and Marine Hospital Service,
Washington, D. C., August 24, 1903.

Mr. J. C. Smith,
131 Carondelet St., New Orleans, La.

My Dear Sir: I have to acknowledge receipt of your letter of August 17, entering protest against the style and position of the recognition of your services which the Working Party No. 1 of the Yellow Fever Institute has accorded you in its report.

I regret that you seem to have some misapprehension concerning the matter. Before I reached New Orleans in attendance on the meeting of the American Medical Association in May last I had no knowledge whatever of your relations with the working party. I then learned for the first time that you had met with them and that a definite promise had been made to you as to recognition, and that it was believed that no such recognition had been inserted in the report.

The report was already in print and after your call upon me, *on consulting an advance copy in my possession, I found that it was true that there was no recognition of you in it.* I thereupon caused the issue of the publication to be suspended to permit inquiry into the matter. I found that the recognition had been promised and determined that the promise should be kept. This involved a board of inquiry and as a result the recognition was restored in the report though it required an alteration in the printer's form to do so.

The report was then published and issued, and as published contains the recognition of your services in the very terms in which it was promised to you and agreed upon by the three members of the working party.

Respectfully
(Signed) Walter Wyman,
Surgeon General.

(The italics are mine.)

To which the following reply, concluding the correspondence, was sent:

New Orleans, La.,
September 1, 1903.

General Walter Wyman,
Washington, D. C.

My Dear Sir: In reply to yours of August 24 I will say that on my part there is not the least 'misapprehension concerning the matter.' Whether the acknowledgment now in the report is, or is not, the same as was placed there originally and afterwards suppressed, does not concern me, as I was not afforded the opportunity of judging if it were commensurate with the services I had rendered the working party.

Further, Dr. Pothier, a member of the working party, has just assured me that when he signed the report the acknowledgment then accorded me *was placed in the text treating on the parasite,* so you will note that the suppressed acknowledgment was not even restored as it was originally.

That I had made proper effort to learn from the chairman of the working party if I were to be acknowledged for my services, and in what terms this acknowledgment was to be, you know from my reply, dated March 10, to Dr. Parker's letter dated March 6; that I failed, you also know from the fact of Dr. Parker treating my request for this information with silence.

I hold that the form of recognition which should have been considered was that which emanated from me, and which I gave you upon your own request. I also hold that if it were thought that I was claiming too much, the proper and just thing to have done was to have afforded me the opportunity of strengthening, by witnesses, what was related in my brief given to you.

In conclusion, I will say that I consider that I have been treated unfairly in this whole business, and as I am actuated by the commendable desire to be permanently connected with the results of my work on the parasite, I shall, without un-

necessary delay, appeal to all scientific men and let each judge as to the justice of my claim—*as being the first to correctly interpret and give value to the things seen in the bodies of the infected mosquitoes.*

Yours truly,
(Signed) J. C. SMITH.

In conclusion, I will say that I am willing to rest my case on the facts related, without analysis or argument, and leave it to the judgment of my readers if I am not entitled to the recognition I claimed at the hands of Surgeon-General Wyman and the party. That in the text treating on the parasite the following acknowledgment be placed:

"That the commission (or working party) is indebted to Mr. J. C. Smith, of New Orleans, La., for his valuable services in working out the sexual life-history of the parasite in the body of the mosquito."

J. C. SMITH.

NEW ORLEANS, LA.,
September 24, 1903.

SOME RECENT APPLICATIONS OF THE A. O. U. CODE.

TO THE EDITOR OF SCIENCE: It is desirable that there should be public discussion of disputed cases in nomenclature, for in no other way can the weak points in codes, or in their application, be so well brought out. For this reason SCIENCE appears to be the proper place for the following criticism.

Dr. Stejneger (*Proc. U. S. Nat. Mus.*, 1903, p. 152) sets aside the specific portion of *Coronella sayi* Holbr. (Ed. 2, Vol. III., 1842), for sixty years used for Say's King-snake, now *Ophibolus getulus sayi*, for the reason that Holbrook was under the misapprehension that his species was identical with *Coluber sayi* Schlegel (1837), which is now *Pityophis sayi*, a pine snake, and included that name in his list of references. In consequence of which, a new specific name, *holbrooki* Stej. takes its place. The rule relied on for the change is Canon XXXIII. of the A. O. U. Code, which provides that 'a specific * * * name is to be changed when it has been * * * used previously in combination with the same generic name.' It is quite true that in this place Holbrook does cite Schlegel's name among his references, and in that was clearly wrong. But as he puts his species in another genus, it does not appear that the application of this rule is so clear as to be compulsory. Curiously enough, however, a better ground exists upon which the vacating of Holbrook's name might be urged under the rule. Holbrook's first description of the species was under the name *Coluber sayi* Dekay, in the lately discovered fourth volume of his first edition (1840), now in the Academy's library. The only reference given here is 'Dekay mss.'; Schlegel not being mentioned. For some unknown reason Holbrook tried to suppress this volume, and in his second edition he gave the same description and plate under the name *Coronella sayi* Schlegel.

It is of course true that by a strict construction, which is usually a narrow one, the rule quoted might be applied here, Holbrook having first used *sayi* in connection with the generic name used by Schlegel, but the fact remains that Holbrook was indisputably the first to describe publicly and name the species from original specimens, and that he subsequently placed it in a different genus where it is still retained by high authority among herpetologists, his only error being in assuming that Schlegel's species was the same as his. If, under the A. O. U. Code, there is no escape from applying the rule here, then it is one of the cases where the code conflicts with justice and common sense.

While I am on the subject I may mention also Cope's substitution (*Proc. U. S. Nat. Mus.*, 1888, p. 392) of *Natrix* Laurenti (1768) for the well-known *Tropidonotus* Kuhl (1826), on the ground that while *Natrix* was a heterogeneous collection of species, *Natrix vulgaris*, which is a *Tropidonotus*, was its type. Here we have a method of determining types which leads to the absurdity of placing a group of snakes with keeled and conspicuously rough scales in a genus whose author among its definitions expressly says '*Truncus glaber, nitidus.*'

ARTHUR ERWIN BROWN.

ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, August 5, 1903.

A HITHERTO UNDESCRIBED VISUAL PHENOMENON.

To the Editor of Science: So far as I know, the curious visual fact I am about to describe has not been noted by psychologists, and as it may, and seems to me really to be of practical as well as psychologic importance, I wish to ask your readers to verify and, possibly, to explain it.

For several years I have observed the following peculiar appearance of a distant light at night: The electric (incandescent) lamps of a town two or three miles away and below me, when observed fixedly and singly, have distinct appearances of movement, if seen under certain conditions. These conditions are as follows:

1. The observer must sit in the darkness, *i. e.*, without visible objects about, which would fix a number of objects in the attention and prevent the needed indefiniteness, or lack of 'fixing' necessity.

2. The night must be dark, moonless, etc., so that there is no multiplicity of distant objects to arouse the definite ocular fixation, or localizing necessity, which prevents the indefiniteness, the lack of sensational or topographic features required to produce the phenomenon in question.

3. By means of the hand, interposed shades, etc., one must shut out of the 'field of vision,' as well as possible, all other lights except the one to be observed.

4. The movements of the distant light are made more manifest and pronounced by: (*a*) closing one eye; (*b*) not winking; (*c*) immobility of the head; (*d*) steadiness and continuousness of the gaze.

The distant light must be strong and rich enough so that (as happens with weak powers) the image does not fade to invisibility with constant fixation. A star as an object is not so good as a brilliant electric light, because, most stars are too weak in light-power, or other stars are too near by to secure the singleness of object desirable, etc. I have become able by practice to observe the movement in a star, but a beginner will succeed better with a distant electric light. To myself and some friends the movements are observable with both eyes open, but they are more pronounced with a single eye, and besides they have generally a peculiar character with a single eye. Perhaps half the friends who have made the tests do not observe the more decided movements of myself and others. These speak only of a quivering or of slight vibratory movements. The appearances of movements are not those of 'twinkling,' changes in the rays, etc., and only a little experience is required to convince one that they are not caused by clouds, atmospheric radiation or other conditions—in a word they are not 'objective.'

The character of the apparent movements, as they appear to myself and other friends who see them as plainly as myself, is as follows: With the right eye (the head being level, or erect), the light will somewhat slowly move, with varying rapidity, and without regular rhythm or 'beat,' to the right, and often upward—the motion being like that of a small balloon or floating downy seed, in a breeze, moving according to the force, gusts or eddies of the wind. With the left eye alone the movements are usually but not always to the left and also sometimes upward. I suspect the character of the movements will depend upon whether one is right-eyed or left-eyed. (I am convinced that either by necessity or habit one is always partly or preponderantly right-eyed or left-eyed, just as one is right-handed or left-handed—but this, *ad interim*, is 'another matter.') I have made a number of experiments as to the influence of position of the head upon the movements, but the consideration of these may also be omitted.

As to the explanation of the phenomenon:

1. It is not, I think, due to the spreading of the tears over the cornea in an irregular manner; nor to their drying, producing a slight warping of the same or irregularity of transparency.

2. Nor to lymph-movements in the substance of the cornea.

3. Nor to muscæ volitantes—which are not uniform in direction, etc.

4. Nor to movements of the blood corpuscles in the capillaries of the retina, for

the same reasons, and also because the macula has no capillaries.

In other words, the movements are not ocular in origin, unless in a last analysis they are due to a shifting of the functional activity from one set of macular cones to another. The direction of the movements with a single eye seems to forbid this supposition, and one is driven to think of them as caused by the mechanism or physiology of the sensation-making centers in the cuneus of the occipital lobe—the cerebral center for vision. The fact suggests several not uninteresting queries as to the psychology and physiology of sensation.

The practical bearings of the phenomenon are of far greater importance and interest, and may be vaguely indicated as follows: There is no doubt, of course, as to the fact of the subjective production of images, ghosts, wraiths, telepathic visions, animals, snakes, etc., in delirium tremens, in clairvoyant states, in hypnotic conditions, in pathologic conditions of the mind and body and even in some people in health, when the mind is in a state of heightened sensibility, etc. It will be remembered that the vast majority of these subjective sensations occur in the night, in dim light, etc. If they occur with the eyes closed, that does not change the essential psychologic law of the apparent action and movement of the image, which must be conditioned upon the physiology or mechanics of visualization. The apparent movements of the images will obey the same laws of seeing, shifting as those of the distant light in the night. The facts of crystal-gazing, apart from the mere subjective creation of the images (about which, I take it, there is no doubt in the minds of students) and especially of the movements of these images, may receive a psychologic explanation, at least some light and rationality, from the analogy of the movements of the light I have described.

Geo. M. Gould.

Philadelphia,
September 27, 1903.

SHORTER ARTICLES.

BACTERIAL SPOT, A NEW DISEASE OF CARNATIONS.

We have recently received for examination from Pennsylvania and the District of Columbia a number of carnation plants suffering from a spot disease of the leaves and stems that appears to be quite distinct from anything hitherto described. In its earlier stages the disease looks something like stigmonose, or puncture disease, but the small spots are usually surrounded by a narrow, water-soaked area or ring, while the center of the spot is usually slightly brown. As the spots grow larger they resemble more the ordinary carnation spot caused by *Septoria dianthi.* The water-soaked marginal area, however, makes it easy to distinguish from this latter disease. The spots increase in size more rapidly in soft-leaved varieties and soon collapse and dry, leaving a brown, sunken area. Badly diseased leaves soon wither. Microscopical examination shows that the spots in all stages are filled with bacteria, which, in the early and middle stages of the disease, are usually in pure cultures. These bacteria grow rapidly in beef broth and nutrient agar (acidity plus 15 of Fuller's scale) and on ten per cent. nutrient gelatine of the same acidity, but where malic acid is added to the nutrient gelatine at the rate of one half gram per one hundred cubic centimeters, the growth is extremely slow. The germ also grows well upon steamed potato. The colonies are round and unbranched, pearly white, wet and shining, and do not spread rapidly over the culture medium. After a few days the central portions of the colonies break up into zooglœa. The complete cultural characters for various media have not yet been determined, but are now being investigated. It is evident that the organism causing this disease is quite distinct from the orange-colored one, *Bacterium dianthi,* described by Arthur and Bolley as the cause of '*Bacteriosis*' of carnations. Inoculation experiments have been made, both from a maceration of young diseased spots in distilled water and from pure cultures in beef bouillon. Bacteria from both sources, when applied to the surface of leaves, old or young,

where there was the slightest abrasion of the epidermis, produced by a fine needle, gave characteristic spots filled with bacteria in from forty-eight to seventy-two hours. Characteristic spots have also been secured by simply brushing the bacteria on the uninjured leaves. Under natural conditions the bacteria appear to gain entrance to the leaves and stems from the slight injuries produced by the red spider and by other causes. Slugs have been observed eating diseased spots, and infection from slug bites was observed. It is also evident that the organism has other ways of gaining entrance to the tissues, possibly through the stomata. We have found the disease so far on the varieties Mrs. McKinley, Mrs. Nelson, Lawson, and Crane, and it will doubtless be found on numerous other varieties. In some cases observed nearly every leaf and many of the stems were so badly spotted that it would be practically impossible to save the plants. When the disease has not progressed so far, however, it can be checked by thoroughly cleaning the plants of all diseased leaves and stems and burning what is removed. Then syringe the plants with a solution of commercial formaldehyde, one part to five hundred parts of water. This should be done in the forenoon so that the plants may dry before night. Syringe occasionally with water under pressure to keep down the red spider. Give the plants as much light and air as possible and keep the foliage as dry as practicable. Give the plants a second thorough cleaning after the new growth is well started and follow with a second light syringing with formaldehyde solution. It is probable that these recommendations may be modified after further investigation, but the procedure outlined is the best we can suggest at the present time.

A careful study of the disease and the organism causing it will be completed as soon as possible. Messrs. Lloyd Tenny and J. B. Rorer, assistants in pathology, are actively aiding in the investigation.

A. F. Woods,
Pathologist and Physiologist.
U. S. Department of Agriculture.

THE FRONTIER OF PHYSIOGRAPHY.

The term physiography, as generally applied in geological studies, has become associated with and is inclusive of glacial geology; and from the character of the formations studied is sometimes referred to as superficial or surficial geology. The alternative use of the latter terms calls attention, also, to the fact that the field of its inquiries has not been generally regarded as extending deep into the earth's crust. As time has gone on the work of physiography has, in fact, been more and more sharply differentiated from that upon the consolidated portion of the lithosphere; and geologists of a special class have arisen known as physiographers, glacialists or surficial geologists—which, while not by any means equivalent terms, are yet regarded as all properly referring to men trained in a special way.

The features of the land areas are by this school of geologists interpreted to be largely fashioned under the action of water or ice, or both; in the case of the first of the agencies mentioned, according as the action has been affected by epeirogenic movements. The origin of earth sculpture has been, therefore, largely referred to the changes brought about by successive geographic cycles, during which elevation and tilting of the crust follow upon a period of subsidence. In a subordinate degree the relative hardness of the underlying rocks is brought into account by the modern school. As a result of this type of specialization or special generalization stress has been laid upon the *general* contours which are characteristic of a district or province, and with remarkable readiness and accuracy the stage of a geographic cycle through which a province is passing, and many of the earlier events of the cycle as well, are determined.

The unconsolidated deposits in glaciated regions have been further studied with minuteness as regards their form and extent as well as their composition, and an elaborate classification of them has been adopted. To the consolidated or 'hard' rocks this study has not, however, been extended; and, beyond the fixing of what may be termed erosional ear marks to determine the agent and the stage

of a geographic cycle, little has been attempted. The significance of the great geographic lines of a region, the breaks in the continuity of mountain ranges, the direction of cliff lines, the position of cataracts in relation to one another (in a unique instance called a 'fall line'), the relation in direction of strong topographic lines to water courses, and, above all, to geologic boundaries—in fact, the more impressive manifestations of nature through surface configuration, seem not to have been included in the field of study of physiography. This neglected field is no doubt quite as much within the province of the student of the consolidated crust of the lithosphere—the worker upon the 'hard geology'—who, from his knowledge of mountain structure, is the one best fitted to cope with the problems involved in the interpretation of these complex phenomena. It need, therefore, be no reflection upon the modern physiographer that he has left almost untouched this department of physiography strictly so-called; and the rather sharp differentiation of structural from physiographic geology is doubtless responsible for the fact that exploitation of this frontier of physiography is now only beginning.

The neglected field of study sketched in the above paragraph may be described as the inquiry into the configuration of the earth's surface, and particularly that of its rock basement, as this is related to rock composition and structure. In contrast with physiography, as that term is now applied, it discusses the relation of earth physiognomy to orogeny, rather than to epeirogeny. It gives comparatively little attention to the characters of erosional contours, but endeavors to decipher beneath those obscuring curves, as upon a weather-worn and moss-grown monument, the partly effaced characters which have been chiseled in an earlier period. The attention is focused, therefore, upon the *direction*—the *orientation*—of the earlier lines. The questions asked are not whether for a given province an infantile or a mature stage of erosion or one of rejuvenation, is indicated; but rather what are the cardinal directions of lineaments, and how are they related to geologic boundaries and to other structure planes within the lithosphere. It is, in a word, the *architecture of the earth's surface*—the *tectonic geography*—that is considered, as has been happily expressed by a recent French writer (Barré, 'L'architecture du sol de la France,' Paris, 1903). The increasing frequency with which the term orography has been used by continental writers for studies bordering upon this field (vide especially Kotô, 'An Orographic Sketch of Korea,' Tokyo, 1903) suggests the appropriateness of a general term to designate this division of physiography or geomorphology. The term orology (the science of mountain chains), which was used with special fitness by Gilbert in connection with his classical studies of the basin ranges of the western United States, would appear, however, better adapted for the purpose than orography, for it may be presumed that physiology, rather than physiography would have come into use save for the limitations already placed upon that term. Both these terms fail, however, to emphasize sufficiently the importance of physiographic development, and as indicating the respective provinces of the two widely different lines of investigation the terms *epeirogenic physiography* and *orogenic physiography* may be better employed.

Studies upon which the writer has been engaged for a number of years within the province of southwestern New England have been directed toward the discovery of methods by which the relationships of physiographic lineaments to tectonic structures may be disclosed. The results, when reviewed in their relations to the more marked physiographic features of the Atlantic coast region, are comprised in a forthcoming monograph of the United States Geological Survey, and indicate that for a large area the earth's physiognomy is the outward expression of its internal structure. These conclusions have followed from extension of the pregnant generalizations of Professor Edouard Suess, of Vienna—generalizations which have already borne such rich fruit upon the other side of the Atlantic. It is the writer's belief that the exploitation of this frontier region of orogenic physiog-

raphy will afford ample returns to science, and that the key-note of the inquiry should be the more precise observation of lineamental orientation.

William Herbert Hobbs.
University of Wisconsin,
September 25, 1903.

BOTANICAL NOTES.

A NEW EDITION OF DETMER'S PRAKTIKUM.

For many years botanists have been acquainted with the very useful little book on plant physiology prepared by Doctor Detmer, of the University of Jena, and intended to be a laboratory handbook under the title of 'Das Kleine Pflanzenphysiologische Prakticum.' This little book has passed through a number of editions, and has been used widely in plant physiological laboratories. The present edition, which bears date of February, 1903, is an enlargement and improvement of the previous editions. It is essentially the same as the earlier editions and is illustrated in the same admirable manner. American botanists can not but envy the German botanists when it is remembered that this book of nearly three hundred pages is sold for a little more than six Marks. It should be even more largely used than its predecessors.

THE ALGÆ OF NORTHWESTERN AMERICA.

An interesting paper entitled 'The Algæ of Northwestern America' came to hand recently, as one of the University of California publications. It is by Professor W. A. Setchell and N. L. Gardner. It is an attempt at a rather exhaustive account of the algæ of the northwestern coast of North America. It is illustrated with eleven good plates, and altogether is a very excellent paper. The bibliography appears to be quite complete.

The two numbers of Engler's 'Pflanzenreich,' which have recently made their appearance, are devoted to the Orchidaceæ (in part) and the Eriocaulaceæ. The first takes up merely one section of the great family, but this is of interest to us since it includes the lady slippers (of the genus *Cypripedium* and related genera). The treatment is very full, and can not help throwing a great amount of light upon this portion of the orchid family. In passing it may be remarked that Pfitzer, the author, insists upon the spelling *Cypripedilum,* instead of that which is ordinarily followed. The illustrations are excellent. The other number is by Ruhland, and here the treatment is very much like that given by Pfitzer. These successive numbers of Engler's publication indicate that this is to be one of the great publications in botanical literature.

Charles E. Bessey.
University of Nebraska.

STUDIES OF THE FOOD VALUE OF FRUIT AT THE UNIVERSITY OF CALIFORNIA.

According to a bulletin of the U. S. Department of Agriculture Professor M. E. Jaffa has carried on at the University of California, in cooperation with the U. S. Department of Agriculture, a number of investigations which have to do with the food value of fruits and nuts, the special object of this and the earlier work which it continues being to study the value of such foods when they constitute an integral part of the diet.

Nine dietary studies and 31 digestion experiments were made, part of them with persons who had lived for a number of years on a strictly fruit and nut diet, and others with university students who had been accustomed to the ordinary fare. In the majority of the dietary studies and all but one of the digestion experiments fruit and nuts constituted all or almost all of the diet. Thus, in one series of tests the daily ration consisted of apples and bananas, alone or in combination, eaten with walnuts, almonds, Brazil nuts, or pecans. In other experiments different combinations of grapes, pears, figs, walnuts, and other fruits and nuts were eaten with small quantities of milk, cereal breakfast foods, etc., the latter articles being taken simply to give a relish to the experimental dietary combinations, some of which were rather unusual.

In connection with this work the nutritive value of individual fruits and nuts was studied and many data were collected and summarized regarding the composition and

energy value of these materials, an interesting feature of the work being a comparison, on a pecuniary basis, of these and some common foods as sources of protein and energy. In general, it may be said that the chief nutrients in fruit consist of sugars and other carbohydrates and in nuts of protein and fat. In other words, while both fruits and nuts furnish the body with energy, nuts furnish some building material (protein) as well. Some idea of the range may be gained from the fact that at ordinary retail prices in the United States, 10 cents expended for fresh grapes will supply the body with about 830 calories of energy, and in the case of dried apples or apricots will supply about 1,200 calories, as compared with 6,600 calories from 10 cents' worth of wheat flour. In the case of almonds this sum will supply 0.08 pound protein and about 1,100 calories of energy, and in the case of peanuts 0.28 pound protein and about 2,800 calories, while expended for cheese it would provide 0.17 pound protein and about 1,300 calories, and for flour 0.46 pound protein, as well as the large amount of energy noted above.

Although some of the dietaries showed that it is quite possible to obtain the needed protein and energy from a fruitarian diet, the majority of those studied fell below the tentative dietary standards. It is hardly just to ascribe this entirely to the form of diet since the same people might have consumed no larger quantities of nutrients on an ordinary mixed diet. The nutritive value of the fruitarian diet is perhaps most clearly shown in the case of one of these subjects, a university student, who though entirely unaccustomed to such fare gradually changed from an ordinary mixed diet to one of fruits and nuts without apparent loss of strength or health. He was then able for the eight days of the experiment to carry on his usual college duties and for a part of the time also performed heavy physical work on an exclusive fruitarian diet without material loss of weight.

The cost of the fruitarian diet per person per day varied from 18 to 46 cents, values which compare favorably with those found for an ordinary mixed diet.

Although it is undoubtedly advisable to wait until more data have been gathered before making definite statements regarding the digestibility of different fruits and nuts, enough work has been done to show that they are quite thoroughly digested and have a much higher nutritive value than is popularly attributed to them. In view of this it is certainly an error to consider nuts merely as an accessory to an already heavy meal and to regard fruit merely as something of value for its pleasant flavor or for its hygienic or medicinal virtues.

As shown by their composition and digestibility, both fruit and nuts can be favorably compared with other and more common foods. As sources of carbohydrates, fruits at ordinary prices are not expensive; and as sources of protein and fats, nuts at usual prices are reasonable foods.

In the investigations at the University of California the question of the wholesomeness of a long-continued diet of fruit and nuts is not taken up. The agreement of one food or another with any person is frequently more or less a matter of personal idiosyncrasy, but it seems fair to say that those with whom nuts and fruits agree can, if they desire, readily secure a considerable part of their nutritive material from such sources.

SCIENTIFIC NOTES AND NEWS.

The National Academy of Sciences will hold its autumn meeting in Chicago, beginning on November 17.

In accordance with the pleasant custom of German universities, Professor E. W. Hilgard of the University of California has received from the University of Heidelberg on the occasion of the fiftieth anniversary of his graduation as doctor of philosophy, October 7th, a new diploma reconferring the title, which in addition to the previous formula, contains a general summary of the scientific work done by him, with the congratulations of the faculty. On the anniversary day Professor Hilgard also received a congratulatory address from his colleagues of the University of California.

The American Academy of Arts and Sciences has elected as foreign honorary members, Charles Emile Picard, of Paris, in place of the late H. A. E. A. Faye, and Joseph Larmor, of Cambridge, England, in place of the late Sir George Gabriel Stokes.

The daily papers state that the scientific committee of the Congress of Arts and Sciences of the St. Louis Exposition, consisting of Dr. Simon Newcomb, Washington; Professor Hugo Münsterberg, Harvard University, and Professor Albion W. Small, the University of Chicago, made its report in New York on October 14 to the director of congresses, Mr. Howard J. Rogers, and to President Nicholas Murray Butler, chairman of the administrative board. The members of the committee were in Europe for four months, and of the invitations presented to leading scientific men and scholars, 114 have been accepted.

Professor Carl H. Eigenmann, of Indiana University, has gone to Cuba to continue the work of investigating the blind fishes of that island.

Mr. G. H. Marx, assistant professor of mechanical engineering at Stanford University, has received a year's leave of absence which he will spend in Germany.

Dr. E. D. Starbuck, assistant professor of education in Stanford University, has been granted a year's leave of absence, and is at present in England. It is said that he will not return to Stanford University, but will accept a position in the east.

M. L. H. Uillier, professor of physics at the Lyceum at Nantes, has been made director of the Meteorological Observatory in that city.

It is stated in *Nature* that Mr. H. Maxwell Lefroy, who has been appointed entomologist to the Government of India, is to be stationed at Surat, in the Bombay Presidency, pending the establishment of the permanent headquarters of the Imperial Agricultural Department now being organized under the orders of Lord Curzon.

Mr. S. I. Kuwana, M.S. (Stanford), has been appointed entomologist at the Central Agricultural Experiment Station, Nishigahara, Tokyo. Mr. Kuwana's special studies have been given largely to scale insects and to the Coccidæ of Japan (No. XXVII., Contrib. to Biology, Hopkins Seaside Lab., 1902). He has monographed the Japanese species as at present known.

Charles V. Piper, of the Washington College and Station, has accepted an appointment as botanist in the Division of Agrostology, and will also have charge of the herbarium of grasses.

Alfred M. Sanchez, an assistant in the Bureau of Soils, has been appointed in the Bureau of Agriculture of the Philippines, where he will continue the soil investigations carried on last year by C. W. Dorsey.

Professor C. P. Gillett, entomologist at the Agricultural College at Fort Collins, Col., has been appointed chief entomologist of the St. Louis Exposition.

The twenty-first congress of the American Ornithologists' Union will convene in Philadelphia on Monday, November 16, at 8 P. M. The evening session will be devoted to the election of officers and the transaction of other routine business. The meetings, open to the public and devoted to the reading and discussion of scientific papers, will be held in the lecture hall of the Academy of Natural Sciences (Logan Square), beginning on Tuesday, November 17, and continuing for three days. Information regarding the congress can be had by addressing the secretary, Mr. John H. Sage, Portland, Conn.

A meeting of the American Physical Society will be held at Columbia University on October 31.

The American Institute of Mining Engineers held its eighty-fifth meeting on October 13 in New York City, under the presidency of Mr. Albert R. Ledoux.

The fifth International Congress of Gynecology will be held at St. Petersburg in September, 1905.

An international exhibition of the manufacture and industrial applications of alcohol will be held in Vienna in April and May, 1904.

THE New York Zoological Park has received during the past week a consignment of animals from Hagenbeck's agency at Hamburg. The collection includes a pair of giraffes, valued at $15,000 and some twenty-five other animals.

A PRELIMINARY statement showing the coal production of the United States, prepared by Mr. Edward W. Parker, statistician, has just been issued by the United States Geological Survey. The statistics, though subject to slight revision and correction because of a few incomplete returns, are sufficiently correct to enable comparisons to be made between the production of 1902 and that of former years. For the first time in the history of the United States the production of coal has reached a total of over 300,000,000 short tons, showing an actual output of 300,930,659 tons of 2000 pounds, valued at $373,133,843. Of this total, the output of anthracite coal amounted to 36,865,710 long tons (equivalent to 41,289,595 short tons), which, as compared with production of 60,242,560 long tons in 1901, shows a decrease of 23,376,850 long tons, or almost 40 per cent. This decrease, as is well known, was due entirely to the suspension of operations by the strike in the anthracite region from May 10 to October 23, a little over five months. Had it not been for the strike, which practically stopped production in the anthracite region for this length of time, the output for the year would have probably attained a total of over 65,000,000 long tons. The value at the mines of the product in 1902 amounted to $81,016,937, as against $112,504,020 in 1901, a loss of about 27 per cent. The average value of the marketed coal sold during the year at the mines was $2.50 per long ton, the value in 1901 having been $2.05. The comparatively small amount of anthracite which was mined during the strike, which brought such exorbitant prices, did not have the effect on the total production that might have been expected.

IN his report to the United States Geological Survey on the production of petroleum in 1902, now in press, Mr. F. H. Oliphant gives the following table showing approximately the production of crude petroleum in all the known countries of the world, together with the percentages of each for 1902, in terms of United States barrels. A small estimated quantity is placed under the head of 'all other countries,' included in which is the primitive production in several of the South American States, and in Algeria, Persia, the Philippines and China, from which no returns could be secured. The total increase in 1902 amounted to almost 7 per cent. as compared with 1901, and to almost 20 per cent, as compared with 1900. The most conspicuous items in the list are the increase in the production of the United States and the decrease in the production of Russia, the result being that the output of these two countries reached nearly the same figures in 1902. In 1902 the United States and Russia produced 91.08 per cent. of the total output, as compared with 93.22 per cent. in 1901 and with 94.11 per cent. in 1900. Of the remaining 8.92 per cent. produced by all other countries, Sumatra, Java, Borneo, Galicia and Roumania, which furnished only 4.65 per cent. in 1901, furnished 6.82 per cent. in 1902, leaving 2.10 per cent. of the total as the output of the other producing countries.

Country.	Quantity (Barrels).	Percentage of Total.
United States	80,894,590	45.64
Canada	520,000	.29
Peru	60,000	.03
Russia	80,540,045	45.44
Galicia	4,142,160	2.35
Sumatra, Java, Borneo	5,860,000	3.31
Roumania	2,059,930	1.16
India	1,570,500	.89
Japan	1,193,000	.67
Germany	353,675	.20
Italy	12,000	.02
All other Countries	26,000	
Total	177,231,900	100.00

UNIVERSITY AND EDUCATIONAL NEWS.

L. H. SEVERANCE, of Cleveland, has agreed to give $100,000 toward the fund of $1,000,000 which it is proposed to raise as an endowment for Wooster University.

THE visiting committee having in charge the raising of money to build Emerson Hall for the Department of Philosophy at Harvard University has turned over to the treas-

urer of Harvard College $154,000, $4,000 more than it was originally intended to collect. The committee hopes to raise the total amount to $200,000 before proceeding to erect the building.

The last session of the University of Pennsylvania appropriated $25,000 to equip a laboratory for X-ray research and Finsen's light apparatus at the Hospital of the University of Pennsylvania. Dr. Henry K. Pancoast has charge of the work.

The State University of Iowa, at Iowa City, has received a rather unusual but useful gift from Mr. and Mrs. Euclid Sanders, both graduates of the institution. The gift comprises a grant of the Terrill mill dam on the Iowa River, a mile above the university campus, with the water power rights pertaining thereto, together with the deed of a strip of land along the east bank of the river. The dam will yield upwards of five hundred horse power. A water power plant will be erected, in connection with which a hydraulic laboratory will be equipped. It is also proposed to construct a reservoir on a neighboring hilltop in order to secure a considerable head of water for experimental purposes. A portion of the power developed will be used for the generation of electricity to be used in lighting the university buildings and in driving machinery of the various shops and laboratories. At least one wheel berth will be reserved for the conduct of experiments with various forms of water motors.

Owing to the death of Professor Wilbur C. Knight, the position of professor of geology in the University of Wyoming is at present vacant and probably will not be filled for some months. While the salary is not large the advantages are great, for not more than ten hours a week of class work are required and the opportunities for research are varied. The university possesses the most complete collection of jurassic fossils in the United States, except Yale University, and a large part of this material has never been studied or described. Beside this the stratigraphy and physiography of the state remain to be studied as well as the petrography, which has already yielded the Leucite Hills and Yellowstone Park.

Dr. Francis Lindley Patton, formerly president of Princeton University, was installed as president of Princeton Theological Seminary on the 15th inst.

Professor J. E. Todd, owing to dissatisfaction with the administration of the university, has resigned his position as professor of geology and mineralogy in the University of South Dakota, which he has held for over eleven years. He consequently also ceases to be state geologist.

Dr. Arthur W. Smith has been appointed professor of physics at the University of Michigan.

Roy Titus Wells, Ph.D. (Clark), has been appointed assistant professor in charge of electrical engineering in the newly organized School of Applied Science of the State University of Iowa, at Iowa City. A new electrical laboratory is now being equipped under his direction.

Mr. Thomas T. Reed, E.M. (Columbia), has recently been advanced to the position of associate professor of mining and metallurgy in the University of Wyoming, preparatory to the creation of a separate department of mining and metallurgy.

Mr. Robert E. Snodgrass, formerly assistant professor of zoology and embryology in the Washington State Agricultural College, has been appointed instructor in entomology in Stanford University.

Two important professorships are about to be filled at Cambridge University, that of physiology vacant by the resignation of Professor Foster and that of mechanism and applied mechanics vacant by the resignation of Professor Ewing.

Owing to the appointment of Dr. Martin to the directorship of the Lister Institute, the chair of physiology is vacant at the University of Melbourne.

Mr. R. C. Punnett, of Gonville and Caius College, Cambridge, has been appointed demonstrator of comparative anatomy in the university.

Robert Henry Thurston, director of Sibley College and Professor of Mechanical Engineering at Cornell University, one of the editors of this Journal, died at Ithaca on October 25, on his sixty-fourth birthday.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 30, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*ADDRESS OF THE PRESIDENT OF THE SECTION OF ANTHROPOLOGY OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

IT is now nearly twenty years since anthropology attained to the dignity of being awarded a special and independent section in this association, and I believe it is generally admitted that during this period the valuable nature of many of the contributions, the vigor of the discussions and the large attendance of members have amply justified the establishment and continued existence of this section.

While the multifarious and diverse nature of the subjects which are grouped under the term anthropology gives a variety and a breadth to our proceedings, which are very refreshing in this age of minute specialism, I feel that it adds very considerably to the difficulty of selecting a subject for a presidential address which will prove of general interest.

A survey of the recent advances in our knowledge of the many important questions which come within the scope of this section would cover too wide a field for the time at my disposal, while a critical examination of the various problems that still await solution might expose me to the temptation of pronouncing opinions on subjects regarding which I could not speak with any real knowledge or experience. To

* Southport meeting, 1903.

avoid such a risk I have decided to limit my remarks to a subject which comes within the range of my own special studies, and to invite your attention to a consideration of some problems arising from the variations in the development of the skull and the brain.

Since the institution of this section the development, growth and racial peculiarities of both skull and brain, and the relation of these two organs to each other, have attracted an ever-increasing amount of attention. The introduction of new and improved methods for the study of the structure of the brain and the activity of an able band of experimenters have revolutionized our knowledge of the anatomy and physiology of the higher nerve centers.

The value of the results thus obtained is greatly enhanced by the consciousness that they bear the promise of still greater advances in the near future. If the results obtained by the craniologists have been less marked, this arises mainly from the nature of the subject, and is certainly not due to any lack of energy on their part. Our craniological collections are continually increasing, and the various prehistoric skull-caps from the Neanderthal to the Trinil still form the basis of interesting and valuable memoirs.

While the additions to our general knowledge of cerebral anatomy and physiology have been so striking, those aspects of these subjects which are of special anthropological interest have made comparatively slight progress, and can not compare in extent and importance with the advantages based upon a study of fossil and recent crania. These facts admit of a ready explanation. Brains of anthropological interest are usually difficult to procure and to keep, and require the use of special and complicated methods for their satisfactory examination, while skulls of the leading races of mankind are readily collected, preserved and studied. Hence it follows that the crania in our anthropological collections are as numerous, well preserved and varied as the brains are few in number and defective, in their state of both preservation and representative character. It may reasonably be anticipated that improved methods of preservation and the growing recognition on the part of anthropologists, museum curators and collectors of the importance of a study of the brain itself will to some extent at least remedy these defects; but so far as prehistoric man is concerned, we can never hope to have any direct evidence of the condition of his higher nerve centers, and must depend for an estimate of his cerebral development upon those more or less perfect skulls which fortunately have resisted for so many ages the corroding hand of time.

I presume we will all admit that the main value of a good collection of human skulls depends upon the light which they can be made to throw upon the relative development of the brains of different races. Such collections possess few, if any, brains taken from these or corresponding skulls, and we are thus dependent upon the study of the skulls alone for an estimate of brain development.

Vigorous attacks have not unfrequently been made upon the craniometric systems at present in general use, and the elaborate tables, compiled with so much trouble, giving the circumference, diameters and corresponding indices of various parts of the skull, are held to afford but little information as to the real nature of skull variations, however useful they may be for purposes of classification. While by no means prepared to express entire agreement with these critics, I must admit that craniologists as a whole have concentrated their attention mainly on the external contour

of the skull, and have paid comparatively little attention to the form of the cranial cavity. The outer surface of the cranium presents features which are due to other factors than brain development, and examination of the cranial cavity not only gives us important information as to brain form, but by affording a comparison between the external and internal surfaces of the cranial wall it gives a valuable clue to the real significance of the external configuration. Beyond determining its capacity we can do but little towards an exact investigation of the cranial cavity without making a section of the skull. Forty years ago Professor Huxley, in his work 'On the Evidence of Man's Place in Nature,' showed the importance of a comparison of the basal with the vaulted portion of the skull, and maintained that until it should become 'an opprobrium to an ethnological collection to possess a single skull which is not bisected longitudinally' there would be 'no safe basis for that ethnological craniology which aspires to give the anatomical characters of the crania of the different races of mankind.' Professor Cleland and Sir William Turner have also insisted upon this method of examination, and only two years ago Professor D. J. Cunningham, in his presidential address to this section, quoted, with approval, the forcible language of Huxley. The curators of craniological collections appear, however, to possess an invincible objection to any such treatment of the specimens under their care. Even in the Hunterian Museum in London, where Huxley himself worked at this subject, among several thousands of skulls, scarcely any have been bisected longitudinally, or had the cranial cavity exposed by a section in any other direction. The method advocated so strongly by Huxley is not only essential to a thorough study of the relations of basicranial axis to the vault of the cranium and to the facial portion of the skull, but also permits of casts being taken of the cranial cavity; a procedure which, I would venture to suggest, has been too much neglected by craniologists.

Every student of anatomy is familiar with the finger-like depressions on the inner surface of the cranial wall, which are described as the impress of the cerebral convolutions; but their exact distribution and the degree to which they are developed according to age, sex, race, etc., still remain to be definitely determined. Indeed, there appears to be a considerable difference of opinion as to the degree of approximation of the outer surface of the brain to the inner surface of the cranial wall. Thus the brain is frequently described as lying upon a water-bed, or as swimming in the cerebro-spinal fluid, while Hyrtle speaks of this fluid as a 'ligamentum suspensorium' for the brain. Such descriptions are misleading when applied to the relation of the cerebral convolutions to the skull. There are, it is true, certain parts of the brain which are surrounded and separated from the skull by a considerable amount of fluid. These, however, are mainly the lower portions, such as the medulla oblongata and pons Varolii, which may be regarded as prolongations of the spinal cord into the cranial cavity. As they contain the centers controlling the action of the circulatory and respiratory organs, they are the most vital parts of the central nervous system, and hence need special protection. They are not, however, concerned with the regulation of complicated voluntary movements, the reception and storage of sensory impressions from lower centers, and the activity of the various mental processes. These functions we must associate with the higher parts of the brain, and

especially with the convolutions of the cerebral hemispheres.

If a cast be taken of the cranial cavity and compared with the brain which had previously been carefully hardened *in situ* before removal, it will be found that the cast not only corresponds in its general form to that of the brain, but shows a considerable number of the cerebral fissures and convolutions. This molding of the inner surface of the skull to the adjacent portions of the cerebral hemispheres is usually much more marked at the base and sides than over the vault. Since the specific gravity of the brain tissue is higher than that of the cerebro-spinal fluid, the cerebrum tends to sink towards the base and the fluid to accumulate over the vault; hence probably these differences admit of a simple mechanical explanation. Except under abnormal conditions, the amount of cerebro-spinal fluid between the skull and the cerebral convolutions is so small that from a cast of the cranial cavity we can obtain not only a good picture of the general shape and size of the higher parts of the brain, but also various details as to the convolutionary pattern. This method has been applied with marked success to the determination of the characters of the brain in various fossil lemurs by Dr. Forsyth Major and Professor R. Burckhardt, and Professor Gustav Schwalbe has made a large series of such casts from his craniological collection in Strassburg. The interesting observations by Schwalbe* on the arrangement of the 'impressiones digitatæ' and 'juga cerebralia,' and their relation to the cerebral convolutions in man, the apes and various other mammals, have directed special attention to a very interesting field of inquiry. As is well known, the marked prominence at the base of the human skull, separating the anterior from the middle fossa, fits into the deep cleft between the frontal and temporal lobes of the brain, and Schwalbe has shown that this ridge is continued—of course in a much less marked form—along the inner surface of the lateral wall of the skull, so that a cast of the cranial cavity presents a shallow but easily recognized groove corresponding to the portion of the Sylvian fissure of the brain separating the frontal and parietal lobes from the temporal lobe. Further, there is a distinct depression for the lodgment of the inferior frontal convolution, and a cast of the middle cranial fossa shows the three external temporal convolutions.

We must now turn to the consideration of the relations of the outer surface of the cranium to its inner surface and to the brain. This question has engaged the attention of experts as well as the 'man in the street' since the time of Gall and Spurzheim, and one might naturally suppose that the last word had been said on the subject. This, however, is far from being the case. All anatomists are agreed that the essential function of the cranium is to form a box for the support and protection of the brain, and it is generally conceded that during the processes of development and growth the form of the cranium is modified in response to the stimulus transmitted to it by the brain. In fact, it is brain growth that determines the form of the cranium, and not the skull that molds the brain into shape. This belief, however, need not be accepted without some reservations. Even the brain may be conceived as being influenced by its immediate environment. There are probably periods of development when the form of the brain is modified by the resistance offered by its coverings, and there are certainly stages

* 'Ueber die Beziehungen zwischen Innenform und Aussenform des Schädels,' *Deutsches Archiv für klinische Medicin*, 1902.

when the brain does not fully occupy the cranial cavity.

At an early period in the phylogeny of the vertebrate skull the structure of the greater part of the cranial wall changes from membranous tissue into cartilage, the portion persisting as membrane being situated near the median dorsal line. In the higher vertebrates the rapid and early expansion of the dorsal part of the fore-brain is so marked that the cartilaginous growth fails to keep pace with it, and more and more of the dorsal wall of the cranium remains membranous, and subsequently ossifies to form membrane bones. Cartilage, though constituting a firmer support to the brain than membrane, does not possess the same capacity of rapid growth and expansion. The head of a young child is relatively large, and its skull is distinguished from that of an adult by the small size of the cartilaginous base of the cranium as compared with the membranous vault. The appearance of top-heaviness in the young skull is gradually obliterated as age advances, by the cartilage continuing slowly to grow after the vault has practically ceased to enlarge. These changes in the shape of the cranium are associated with corresponding alterations in that of the brain, and it appears to me that we have here an illustration of how the conditions of skull growth may modify the general form of the brain.

Whatever may be the precise influences that determine skull and brain growth, there can be no doubt but that within certain limits the external form of the cranium serves as a trustworthy guide to the shape of the brain. Statements such as those by Dr. J. Deniker ('The Races of Man,' p. 53), 'that the inequalities of the external table of the cranial walls have no relation whatever to the irregularities of the inner table, and still less have anything in common with the configuration of the various parts of the brain,' are of too general and sweeping a character. Indeed, various observers have drawn attention to the fact that in certain regions the outer surface of the skull possesses elevations and depressions which closely correspond to definite fissures and convolutions of the brain. Many years ago Sir William Turner, who was a pioneer in cranio-cerebral topography, found that the prominence on the outer surface of the parietal bone, known to anatomists as the parietal eminence, was situated directly superficial to a convolution of the parietal lobe of the brain, which he consequently very appropriately named 'the convolution of the parietal eminence.' Quite recently Professor G. Schwalbe has shown that the position of the third or inferior frontal convolution is indicated by a prominence on the surface of the cranium in the anterior part of the temple. This area of the brain is of special interest to all students of cerebral anatomy and physiology, since it was the discovery by the illustrious French anthropologist and physician, M. Broca, that the left inferior frontal convolution was the center for speech, that laid the scientific foundation of our present knowledge of localization of function in the cerebral cortex. This convolution is well known to be much more highly developed in man than in the anthropoid apes, and the presence of a human cranial speech-bump is usually easily demonstrated. The faculty of speech, however, is such a complicated cerebral function that I would warn the 'new' phrenologist to be cautious in estimating the loquacity of his friends by the degree of prominence of this part of the skull, more particularly as there are other and more trustworthy methods of observation by which he can estimate this capacity.

In addition to the prominences on the

outer surface of the cranium, corresponding to the convolutions of the parietal eminence and the left inferior frontal convolution, the majority of skulls possess a shallow groove marking the position of the Sylvian point and the course of the horizontal limb of the Sylvian fissure. Below these, two other shallow oblique grooves indicate the line of the cerebral fissures which divide the outer surface of the temporal lobe into its three convolutions, termed superior, middle and inferior. Most of these cranial surface markings are partially obscured in the living body by the temporal muscle, but they are of interest as showing that in certain places there is a close correspondence in form between the external surface of the brain and that of the skull. There are, however, distinct limitations in the degree to which the various cerebral fissures and convolutions impress the inner surface of the cranial wall, or are represented by inequalities on its outer aspect. Thus over the vault of the cranium the position of the fissure of Rolando and the shape of the cerebral convolutions in the so-called motor area, which lie in relation to this fissure, can not usually be detected from a cast of the cranial cavity, and are not indicated by depressions or elevations on the surface of the skull, so that the surgeons in planning the seats of operations necessary to expose the various motor centers have to rely mainly upon certain linear and angular measurements made from points frequently remote from these centers.

The cranium is not merely a box developed for the support and protection of the brain, and more or less accurately molded in conformity with the growth of this organ. Its antero-lateral portions afford attachments to the muscles of mastication and support the jaws and teeth, while its posterior part is liable to vary according to the degree of development of the muscles of the nape of the neck. Next to the brain the most important factor in determining cranial form is the condition of the organs of mastication—muscles, jaws and teeth. There is strong evidence in favor of the view that the evolution of man from microcephaly to macrocephaly has been associated with the passages from macrodontic to a microdontic condition. The modifications in the form of the cranium due to the influence of the organs of mastication have been exerted almost entirely upon its external table; hence external measurements of the cranium, as guides to the shape of the cranial cavity and indications of brain development, while fairly trustworthy in the higher races, become less and less so as we examine the skulls of the lower races, of prehistoric man and of the anthropoid apes.

One of the most important measurements of the cranium is that which determines the relation between its length and breadth and thus divides skulls into long or short, together with an intermediate group neither distinctly dolichocephalic nor brachycephalic. These measurements are expressed by an index in which the length is taken as 100. If the proportion of breadth to length is eighty or upwards, the skull is brachycephalic; if between seventy-five and eighty, mesaticephalic; and below seventy-five, dolichocephalic. Such a measurement is not so simple a matter as it might appear at first sight, and craniologists may themselves be classified into groups according as they have selected the nasion, or depression at the root of the nose, the glabella, or prominence above this depression, and the ophryon, a spot just above this prominence, as the anterior point from which to measure the length. In a young child this measurement would practically be the same, whichever of these

three points was chosen, and each point would be about the same distance from the brain. With the appearance of the teeth of the second dentition and the enlargement of the jaws the frontal bone in the region of the eyebrows and just above the root of the nose thickens, and its outer table bulges forward so that it is now no longer parallel with the inner table. Between these tables air cavities gradually extend from the nose, forming the frontal sinuses. Although the existence and significance of these spaces and their influence on the prominence of the eyebrows were the subject of a fierce controversy more than half a century ago between the phrenologists and their opponents, it is only recently that their variations have been carefully investigated.

The frontal sinuses are usually supposed to vary according to the degree of prominence of the glabella and the supra-orbital arches. This, however, is not the case. Thus Schwalbe* has figured a skull in which the sinuses do not project as high as the top of the glabella and supra-orbital prominences, and another in which they extend considerably above these projections. Further, Dr. Logan Turner ('The Accessory Sinuses of the Nose,' 1901), who has made an extensive investigation into these cavities, has shown that in the aboriginal Australian, in whom this region of the skull is unusually prominent, the frontal sinuses are frequently either absent or rudimentary. The ophryon has been selected by some craniologists as the anterior point from which to measure the length of the skull, under the impression that the frontal sinuses do not usually reach above the glabella. Dr. Logan Turner, however, found that out of 174 skulls in which the frontal sinuses were present, in 130 the sinuses extended above the ophryon. In 71 skulls the depth of the sinus at the level of the ophryon varied from 2 mm. to 16 mm., the average being 5.2 mm., while in the same series of skulls the depth at the glabella varied from 3 mm. to 18 mm., with an average depth of 8.5 mm. It thus appears that the selection of the ophryon in preference to the glabella, as giving a more accurate clue to the length of the brain, is based upon erroneous assumptions, and that neither point can be relied upon in the determination of the anterior limit of the cranial cavity.

The difficulties of estimating the extent of the cranial cavity by external measurements and the fallacies that may result from a reliance upon this method are especially marked in the case of the study of the prehistoric human calvaria, such as the Neanderthal and the Trinil, and the skulls of the anthropoid apes.

Statistics are popularly supposed to be capable of proving almost anything, and certainly if you allow craniologists to select their own points from which to measure the length and breadth of the cranium, they will furnish you with tables of measurements showing that one and the same skull is dolichocephalic, mesaticephalic and brachycephalic. Let us take as an illustration an extreme case, such as the skull of an adult male gorilla. Its glabella and supra-orbital arches will be found to project forward, its zygomatic arches outwards, and its transverse occipital crests backwards, far beyond the anterior, lateral and posterior limits of the cranial cavity. These outgrowths are obviously correlated with the enormous development of the muscles of mastication and those of the back of the neck. In a specimen in my possession the greatest length of the cranium, *i. e.*, from glabella to external occipital protuberance, is 195 mm., and the greatest

* 'Studien über *Pithecanthropus erectus*,' *Zeitschrift für Morphologie und Anthropologie*, Bd. I., 1899.

breadth, taken between the outer surfaces of the zygomatic processes of the temporal bone, is 172 mm., giving the marked brachycephalic index of 88.21. The zygomatic processes, however, may reasonably be objected to as indicating the true breadth, and the side wall of the cranium just above the line where the root of this process springs from the squamous portion of the temporal bone will certainly be much nearer the cranial cavity. Measured in this situation, the breadth of the cranium is 118 mm., which gives a length-breadth index 60.51, and thus represents the skull as decidedly dolichocephalic. The transverse occipital crests and the point where these meet in the middle line to form the external occipital protuberance are much more prominent in the male than in the female gorilla, and the estimate of the length of the cranium in this male gorilla may be reduced to 160 mm. by selecting the base of the protuberance in place of its posterior extremity as the posterior end measurement. This raises the index to 73.75, and places the skull near the mesaticephalic group. At the anterior part of the skull the prominent glabella is separated from the inner table of the skull by large air sinuses, so that on a median section of the skull the distance from the glabella to the nearest part of the cranial cavity is 36 mm. We have here, therefore, another outgrowth of the cranial wall which in an examination of the external surface of the skull obscures the extent of the cranial cavity. Accordingly the glabella can not be selected as the anterior point from which to measure the length of the cranium, and must, like the zygomatic arches and occipital protuberance, be excluded from our calculations if we desire to determine a true length-breadth index. The difficulty, however, is to select a definite point on the surface of the cranium to represent its anterior end, which will be free from the objections justly urged against the glabella. Schwalbe suggests the hinder end of the supra-glabellar fossa, which he states often corresponds to the beginning of a more or less distinctly marked frontal crest. I have found this point either difficult to determine or too far back. Thus in my male gorilla the posterior end of this fossa formed by the meeting of the two temporal ridges was 56 mm. behind the glabella, and only 24 mm. from the bregma, while in the female gorilla the temporal ridges do not meet, but there is a low median frontal ridge, which may be considered as bounding posteriorly the supra-glabellar fossa. This point is 22 mm. from the glabella, and between 50 mm. and 60 mm. in front of the bregma.

I would suggest a spot in the median line of the supra-glabellar fossa which is crossed by a transverse line uniting the posterior borders of the external angular processes of the frontal bone. I admit this plan is not free from objections, but it possesses the advantages of being available for both male and female skulls. In my male skull the selection of this point diminishes the length of the cranium by 25 mm., thus reducing it to 137 mm. The breadth being calculated at 114 mm., the index is 83.21, and hence distinctly brachycephalic. The length of the cranial cavity is 118 mm. and the breadth 96 mm., and the length-breadth index is thus the brachycephalic one of 81.36.

I have given these somewhat detailed references to the measurements of this gorilla's skull because they show in a very clear and obvious manner that from an external examination of the skull one might easily be misled as to the size and form of the cranial cavity, and that, in order to determine from external measurements the proportions of the cranial cavity, skull

outgrowths due to other factors than brain growth must be rigorously excluded. Further, these details will serve to emphasize the interesting fact that the gorilla's skull is decidedly brachycephalic. This character is by no means restricted to the gorilla, for it has been clearly proved by Virchow, Schwalbe and others that all the anthropoid apes are markedly round-headed. Ever since the introduction by the illustrious Swedish anthropologist Anders Retzius of a classification of skulls according to the proportions between their length and breadth, great attention has been paid to this peculiarity in different races of mankind. It has been generally held that brachycephaly indicates a higher type of skull than dolichocephaly, and that the increase in the size of the brain in the higher races has tended to produce a brachycephalic skull. When the cranial walls are subject to excessive internal pressure, as in hydrocephalus, the skull tends to become distinctly brachycephalic, as a given extent of wall gives a greater internal cavity in a spherical than in an oval form. In estimating the value of this theory as to the evolutionary line upon which the skull has traveled, it is obvious that the brachycephalic character of the skulls of all the anthropoid apes is a fact which requires consideration.

Although an adult male gorilla such as I have selected presents in an extreme degree outgrowths from the cranial wall masking the true form of the cranial cavity, the same condition, though to a less marked extent, is met with in the human subject. Further, it is interesting to note that the length of the skull is more liable to be increased by such growths than the breadth, since they occur especially over the lower part of the forehead and to a less degree at the back of the skull, while the side walls of the cranium in the region of its greatest breadth generally remain thin.

Few, if any, fossils have attracted an equal amount of attention or given rise to such keen controversies as the Neanderthal and the Trinil skull-caps. According to some authorities, both these skull-caps are undoubtedly human, while others hold that the Neanderthal belongs to an extinct species of the genus *Homo,* and the Trinil is the remains of an extinct genus—*Pithecanthropus erectus* of Dubois —intermediate between man and the anthropoids. One of the most obvious and easily recognized peculiarities of these skull-caps is the very marked prominence of the supra-orbital arches. The glabella-occipital length of the Neanderthal is 204 mm., and the greatest transverse diameter, which is over the parietal region, is 152 mm.—an index of 74.51—while the much smaller Trinil calvaria, with a length of 181 mm. and a breadth of 130 mm., has an index of 71.8. Both these skulls are therefore slightly dolichocephalic. Schwalbe has corrected these figures by making reductions in their lengths on account of the frontal 'outworks,' so that he estimates the true length-breadth index of the Neanderthal as 80 and that of the Trinil as 75.5. These indices, thus raised about 5 per cent., are considered to represent approximately the length-breadth index of the cranial cavity. A comparison of the external and internal measurements of many recent skulls with prominent glabellæ would, I suspect, show a greater difference than that calculated by Schwalbe for the Neanderthal and Trinil specimens. In a male skull, probably an aboriginal Australian, with a cranial capacity of 1227 c.cm. I found that the glabella-occipital length was 189 mm., and the transverse diameter at the parieto-squamous suture 127 mm., which gives an index of 67.20 and makes the skull de-

cidedly dolichocephalic. The length of the cranial cavity, however, was 157 mm. and the breadth 121 mm. (an index of 77.07 and a difference of nearly 10 per cent.), so that while from external measurements the skull is distinctly dolichocephalic, the proportions of its cavity are such that it is mesaticephalic. It is probable that many skulls owe their dolichocephalic reputation simply to the prominence of the glabella and supra-orbital ridges. An excessive development of these structures is also liable to give the erroneous impression of a retreating forehead. In the Australian skull just mentioned the thickness of the cranial wall at the glabella was 22 mm.; from this level upwards it gradually thinned until 45 mm. above the glabella it was only 6 mm. thick. When the bisected skull was placed in the horizontal position the anterior surface of the frontal bone sloped from the glabella upwards and distinctly backwards, while the posterior or cerebral surface was inclined upwards and forwards. In fact, the cranial cavity in this region was separated from the lower part of the forehead by a wedge-shaped area having its apex upwards and its base below at the glabella.

The cranial wall opposite the glabella is not appreciably thicker in the Neanderthal calvaria than in the Australian skull to which I have already referred, and the form of the cranial cavity is not more masked by this prominence in the Neanderthal than in many of the existing races.

Although the Neanderthal skull is by no means complete, the base of the cranium and the face bones being absent, still those parts of the cranial wall are preserved that are specially related to the portion of the brain which subserves all the higher mental processes. It includes the frontal, parietal and upper part of the occipital bones, with parts of the roof of the orbits in front, and of the squamous division of the temporal bones at the sides. On its inner or cranial aspect there are markings by which the boundaries between the cerebrum and the cerebellum can be determined. In a profile view of such a specimen an inio-glabellar line can be drawn which will correspond very closely to the lower boundary of the cerebrum, and indicate a horizontal plane above which the vaulted portion of the skull must have contained nearly the whole of the cerebrum.

Schwalbe* has devised a series of measurements to illustrate what he regards as essential differences between the Neanderthal skull-cap and the corresponding portion of the human skull. From the inio-glabellar line another is drawn at right angles to the highest part of the vault, and by comparing the length of these two lines we can determine the length-height index. According to Schwalbe, this is 40.4 in the Neanderthal, while the minimum in the human skull is 52. He further shows that the frontal portion of the vault, as represented by a glabellar-bregmatic line, forms a smaller angle with the base or inio-glabellar line, and that a vertical line from the posterior end of the frontal bone (bregma) cuts the inio-glabellar further back than in the human subject. Professor King, of Galway, attached special importance to the shape and proportions of the parietal bones, and more particularly to the fact that their mesial borders are shorter than the lower or temporal, whereas the reverse is the case in recent man. This feature is obviously related to the defective expansion of the Neanderthal vault, and Professor Schwalbe also attributes considerable significance to this peculiarity.

Another distinctive feature of the Ne-

* 'Ueber die specifischen Merkmale des Neanderthalschädels,' *Verhandl. der anatomischen Gesellschaft in Bonn*, 1901.

anderthal skull is the relation of the orbits to the cranial wall. Schwalbe shows that its brain-case takes a much smaller share in the formation of the roof of the orbit than it does in recent man, and King pointed out that a line from the anterior inferior angle of the external orbital process of the frontal bone, drawn at right angles to the inio-glabellar line, passed in the Neanderthal in front of the cranial cavity, whereas in man such a line would have a considerable portion of the frontal part of the brain-case anterior to it.

From the combined results of these and other measurements Schwalbe arrives at the very important and interesting conclusion that the Neanderthal skull possesses a number of important peculiarities which differentiate it from the skulls of existing man, and show an approximation towards those of the anthropoid apes. He maintains that in recognizing with King* and Cope† the Neanderthal skull as belonging to a distinct species, *Homo neanderthalensis,* he is only following the usual practice of zoologists and paleontologists, by whom specific characters are frequently founded upon much less marked differences. He maintains that as the Neanderthal skull stands in many of its characters nearer to the higher anthropoids than to recent man, if the Neanderthal type is to be included under the term *Homo sapiens,* then this species ought to be still more extended, so as to embrace the anthropoids.

It is interesting to turn from a perusal of these opinions recently advanced by Schwalbe to consider the grounds on which Huxley and Turner, about forty years ago, opposed the view, which was then being advocated, that the characters of the Neanderthal skull were so distinct from those of any of the existing races as to justify the recognition of a new species of the genus *Homo.* Huxley, while admitting that it was 'the most pithecoid of human skulls,' yet holds that it 'is by no means so isolated as it appears to be at first, but forms in reality the extreme term of a series leading gradually from it to the highest and best developed human crania.' He states that 'it is closely approached by certain Australian skulls and even more nearly by the skulls of certain ancient people who inhabited Denmark during the stone period.' Turner's* observations led him to adopt a similar view to that advanced by Huxley. He compared the Neanderthal calvaria with savage and British crania in the Anatomical Museum of the University of Edinburgh, and found amongst them specimens closely corresponding to the Neanderthal type.

While yielding to no one in my admiration for the thoroughness and ability with which Schwalbe has conducted his elaborate and extensive investigations on this question, I must confess that in my opinion he has not sufficiently recognized the significance of the large cranial capacity of the Neanderthal skull in determining the zoological position of its owner, or made sufficient allowance for the great variations in form which skulls undoubtedly human may present.

The length and breadth of the Neanderthal calvaria are distinctly greater than in many living races, and compensate for its defect in height, so that it was capable of lodging a brain fully equal in volume to that of any existing savage races and at least double that of any anthropoid ape.

A number of the characters upon which Schwalbe relies in differentiating the Neanderthal skull-cap are due to an appreci-

* 'The Reputed Fossil Man of the Neanderthal,' *Journal of Science*, 1864.

† 'The Genealogy of Man,' *The American Naturalist*, Vol. XXVII., 1893.

* 'The Fossil Skull Controversy,' *Journal of Science*, 1864.

able extent to the great development of the glabella and supra-orbital arches. Now these processes are well known to present very striking variations in existing human races. They are usually supposed to be developed as buttresses for the purpose of affording support to the large upper jaw and enable it to resist the pressure of the lower jaw due to the contraction of the powerful muscles of mastication. These processes, however, are usually feebly marked in the microcephalic, prognathous and macrodont negro skull, and may be well developed in the macrocephalic and orthognathous skulls of some of the higher races. Indeed, their variations are too great and their significance too obscure for them to form a basis for the creation of a new species of man. Both Huxley and Turner have shown that the low vault of the Neanderthal calvaria can be closely paralleled by specimens of existing races.

If the characters of the Neanderthal calvaria are so distinctive as to justify the recognition of a new species, a new genus ought to be made for the Trinil skull-cap. In nearly every respect it is distinctly lower in type than the Neanderthal, and yet many of the anatomists who have expressed their opinion on the subject maintain that the Trinil specimen is distinctly human.

Important and interesting as are the facts which may be ascertained from a study of a series of skulls regarding the size and form of the brain, it is evident that there are distinct limits to the knowledge to be obtained from this source. Much additional information as to racial characters would undoubtedly be gained had we collections of brains at all corresponding in number and variety with the skulls in our museums. We know that as a rule the brains of the less civilized races are smaller, and the convolutions and fissures simpler, than those of the more cultured nations; beyond this but little more is definitely determined.

As the results of investigations in human and comparative anatomy, physiology and pathology, we know that definite areas of the cerebral cortex are connected with the action of definite groups of muscles, and that the nervous impulses starting from the organs of smell, sight, hearing and common sensibility reach defined cortical fields. All these, however, do not cover more than a third of the convoluted surface of the brain, and the remaining two thirds are still to a large extent a *terra incognita* so far as their precise function is concerned. Is there a definite localization of special mental qualities or moral tendencies, and if so, where are they situated? These are problems of extreme difficulty, but their interest and importance are difficult to exaggerate. In the solution of this problem anthropologists are bound to take an active and important part. When they have collected information as to the relative development of the various parts of the higher brain in all classes of mankind with the same thoroughness with which they have investigated the racial peculiarities of the skull, the question will be within a measurable distance of solution.

Johnson Symington.

SCIENTIFIC BOOKS.

The Alchemist. By Ben Jonson, edited with introduction, notes and glossary by Charles Montgomery Hathaway, Jr. New York, Henry Holt & Co. 1903. Pp. vi + 373. 8vo.

This comedy was first produced in 1610, and proved a most severe satire on alchemy and an effective exposure of many of the swindles associated with it; in this satisfactory edition Dr. Hathaway has given his readers a text based on the folio of 1616, together with variants of several other early and rare editions.

Prefixed to the text are sections on the history and on the theory of alchemy; these

include its status in England at the period of the production of the play and narratives showing its adaptability to swindling credulous persons at all periods. The editor then points out the originality of Jonson and his slight indebtedness to previous writers; he also draws a picture of Simon Forman, a notorious London quack flourishing in Jonson's day, who probably furnished the author one of the characters of the play (Subtle).

The editor gives many instances of the swindling operations in recent times by pretended alchemists, especially dwelling on the tricks of Morrell and Harris in New York, of Pinter in London, and of the Rev. Mr. Jernegan, of Connecticut (in connection with the fraudulent extraction of gold from sea water), and he gives references to the daily press for particulars. Elsewhere he names the three principal branches of astrology and refers to some of the modern aspects of this pseudo science. In a note on Jonson 'taking in of shaddows with a glass' he writes of catoptiomancy, and refers to the notorious Kelley who acted as 'skryer' for Dr. Dee, in Queen Elizabeth's day.

Following the text are one hundred pages of notes, partly taken from preceding editions, notably Gifford and Whalley; a bibliography of works consulted, in which one misses the names of Hermann Kopp ('Geschichte der Chemie,' 4 vols., 1843, 'Die Alchemie in älterer und neuerer Zeit,' 2 vols., 1886), of William Johnson ('Lexicon chymicum,' London, 1652), and the 'Chymicall Dictionary,' bound with Michael Sandivogius' 'New Light of Alchemie' (London, 1650), but perhaps these were not accessible to Dr. Hathaway.

There is also a glossary of forty columns, and finally an index. Each section is marked by thorough work and painstaking study on the part of the editor; the glossary in particular may be of much assistance in explaining archaic and obsolete terms in the alchemical writings of other authors than Jonson.

The notes refer to passages in a variety of languages, show judicious selection and a wide acquaintance with literature. The deep study of alchemical jargon has familiarized the editor with incomprehensible gibberish to such an extent that he himself is not always perfectly clear. (See note on page 288, last three lines.) And he is sometimes tempted to substitute conjectures for more definite information, especially in discussing the signification of impossible words.

Dr. Hathaway shows the relations which Jonson's comedy bears to John Lyly's 'Gallathea,' printed in 1592, to Gower's and Chaucer's well-known poems, to Lydgate's 'Secrees of old Philisoffers' and to the principal metrical treatises on alchemy preserved by Elias Ashmole in his 'Theatrum Chemicum Britannicum' (London, 1652), from which he gives many citations.

The editor has been very successful in demonstrating that 'Nothing in Jonson is done at random.' The whole work is creditable to the editor, and for its typographical excellence to the publisher.

HENRY CARRINGTON BOLTON.

BLATCHLEY'S ORTHOPTERA OF INDIANA.

IN the Twenty-seventh Annual Report of the Department of Geology and Natural Resources of Indiana, 1902, Mr. W. S. Blatchley, State Geologist, has devoted over 350 pages to the Orthoptera of his state, and under this modest title has given us one of the best pieces of entomological work that has come to us during the present year. Not only are all of the species known to the author to occur in the state fully described, some of them for the first time, but he has given in connection therewith every scrap of information relating to them that he has been able to obtain, either by observation, correspondence or found recorded in entomological literature. The list includes 148 species, many of which are figured, the illustrations consisting of 121 figures, one colored and two uncolored plates, which with a full bibliography and synonymy, keys to families, genera and species found in Indiana, sections relating to the external anatomy of the order, natural enemies, life zones of Indiana, a glossary of terms used in the text, together with a full index, gives the work a

finish that is seldom found in connection with such papers. The author has himself studied the orthoptera of his state in the field, during the last twenty years, and many of the statements given relative to habits have come first hand fresh from the observer. The student of geographical distribution will find much of interest, while even those not especially interested in the technical descriptions will certainly not fail to appreciate the copious notes on habits, abundance, etc., etc., but it will be of the greatest value to those who make a specialty of the orthoptera.

F. M. WEBSTER.

URBANA, ILLINOIS,
September 30, 1903.

SCIENTIFIC JOURNALS AND ARTICLES.

THE closing (October) number of volume 4 of the *Transactions of the American Mathematical Society* contains the following papers: 'On the subgroups of order a power of p in the quaternary abelian group in the Galois field of order p^n,' by L. E. Dickson; 'On the order of linear homogeneous groups,' by H. F. Blichfeldt; 'Non-abelian groups in which every subgroup is abelian,' by G. A. Miller and H. C. Moreno; 'On nilpotent algebras,' by J. B. Shaw; 'On solutions of differential equations which possess an oscillation theorem,' by Helen A. Merrill; 'On the reducibility of linear groups,' by L. E. Dickson; 'Semireducible hypercomplex number systems,' by S. Epsteen; 'A symbolic treatment of the theory of invariants of quadratic differential quantics of n variables,' by H. Maschke; 'Congruences of curves,' by L. P. Eisenhart; 'Similar conics through three points,' by T. J. I'a Bromwich.

THE opening (October) number of volume 10 of the *Bulletin* of the Society contains the following papers: 'Poincaré's Review of Hilbert's Foundations of Geometry,' translated by E. V. Huntington; 'On linear differential congruences,' by S. Epsteen; 'Fields whose elements are linear differential expressions,' by L. E. Dickson; 'On directrix curves of quintic scrolls,' by C. H. Sisam; 'Josiah Willard Gibbs, Ph.D., LL.D., a short sketch and appreciation of his work in pure mathematics,' by P. F. Smith; Notes; New Publications.

THE November number of the *Bulletin* contains: 'Report of the tenth summer meeting of the American Mathematical Society,' by F. N. Cole; 'Report of the committee of the American Mathematical Society on definitions of college entrance requirements'; 'On the congruence $x_{\phi(P)} \equiv 1$, mod. P^n,' by J. Westlund; Review of Mach's Mechanics, by E. B. Wilson; Review of Forsyth's Differential Equations, by E. J. Wilczynski; Notes; New Publications.

The Journal of the Franklin Institute prints, in its October number, the paper of Mr. Thomas M. Gardner, instructor in Sibley College, on 'The Graphics of Carbon-Disulphide, with Formulas and Vapor-Table.'

It is a practically important contribution to the literature of the subject, as it provides the essential entropy-values of a substance which is thought by some authorities to be likely to have importance as the working fluid of a secondary heat-motor, as in the 'waste-heat engines.'

A plate is given exhibiting the properties of the substance having importance in the thermodynamic operations; and another giving the temperature-entropy diagram with MacFarlane Gray's constant-volume lines. Several other plates present the constant-area lines, $pv = C$, the constant-quality lines, $x = C$, the constant-entropy lines, $\phi = C$; and the general temperature-entropy diagram, after Boulvin, completes the series.

A new and extensive table of the properties of the saturated vapor, in the form of the standard steam-tables, provides data hitherto uncomputed and in forms suitable to the thermodynamic discussion of heat-engines employing this substance. The values of n, also, in $pv^n = C$ are determined and the curve is given for adiabatic expansion of qualities ranging from $x = 0.10$ to $x = 1$.

It is shown that, with hyperbolic expansion, the 'quality' of wet fluid improves, the proportion of moisture decreasing; with superheated vapor, this expansion becomes isother-

mal, as with all gases, and all heat supplied is utilized as external work. The constant-quality curves have the equation $pv^{1.0568} = C$. With adiabatic expansion, the quality improves with all mixture in which $x < 0.6$ and the fluid progressively condenses for mixtures of initially $x = 0.7$ and above. The value of n is found to be

$$n = \left(\frac{x}{c}\right)^{\frac{1}{6.36}}; \; xn^{-6.36} = C;$$

the logarithmic curve is given, graphically illustrating the law of variation of n.

The specific volume of CS_2 is 2.6258 times that of air. Its boiling point is, according to Thorpe and Freidburg, 115.88 *F.* and its critical temperature is 504.5° *F.*, at a pressure of about 65 atmospheres.

The paper is one of special value and is the outcome, in part, of work for the Ph.D. at Cornell. R. H. T.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES. SECTION OF BIOLOGY.

THE first meeting of the academic year was held at the American Museum of Natural History on October 12, Professor Wilson acting as temporary chairman. As in former years, this first meeting after the long vacation was devoted to reports on scientific work carried on by members of the section during the summer. The following notes indicate the lines of the work of the members who reported.

Professor Bristol, in association with Professor Mark, of Harvard, directed the summer work at the Bermuda Biological Station. Dr. Hay was very successful in collecting in Wyoming materials for his studies of fossil turtles. Professor Osborn directed explorations in Wyoming, Nebraska and South Dakota in the interest of the American Museum of Natural History, securing much valuable material which supplements collections previously made. Professor Grabau collected in Michigan materials for continuation of his studies on Devonian faunas. Dr. Summer directed the Biological Laboratory of the United States Fish Commission at Woods Hole, Mass. Professor Calkins studied the relation of Protozoa to cancer and smallpox. Professor Crampton continued the accumulation of data relating to selection in Lepidoptera. Mr. Bigelow studied the early embryology of some crustaceans. Mr. Yatsu experimented on regulation and organization of nemertean eggs. Professor Wilson at Naples studied problems of localization and mosaic development of molluscan eggs.

M. A. BIGELOW,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

AT the meeting of the section on October 5, Professor Harold Jacoby and Dr. S. Alfred Mitchell exhibited a combined prismatic transit and zenith telescope. This instrument, just received by the Department of Astronomy of Columbia University, was made by Bamberg of Berlin. It includes all the latest observational devices, including an eye-piece of the Repsold pattern for the automatic registration of transit observations.

Dr. George F. Kunz and Dr. Charles Baskerville gave an exhibition of radium of 300,000 activity, with some notes on the action of the Roentgen ray, ultra-violet light and radium on mineralogical substances. This paper will be published elsewhere in SCIENCE.

S. A. MITCHELL,
Secretary of Section.

DISCUSSION AND CORRESPONDENCE.

THE INTERNATIONAL CONGRESS OF ARTS AND SCIENCE.

TO THE EDITOR OF SCIENCE: I returned only a few days ago from Europe and, therefore, have not seen until now the letter of Professor Dewey in SCIENCE of August 28 and that of Professor Woodward in SCIENCE of September 4, both of which deal with the International Congress of Arts and Science and especially with my essay on that congress, published in the May number of the *Atlantic Monthly.*

Professor Woodward's document gives me hardly a chance for a reply, since I can not see that it contains an argument. It is only a general expression of his contempt, on principle, for every effort to classify sciences from

a logical point of view. "While we may not go out of our way," he says, "to oppose philosophers and literary folk who indulge in such extravagances, it is our duty to repudiate them when they appear in the public press in the guise of science; for they tend only to make science and scientific men ridiculous." It may appear surprising if my chief aim was to make science ridiculous for the amusement of literary folk, that I took my medical degrees and have since been conducting scientific laboratories. But the worst of it is that those 'philosophers and literary folk' who have indulged in the acceptance of a program 'which bordered on absurdity' are the president of the congress, Professor Simon Newcomb, Mr. Pritchett, the president of the Massachusetts Institute of Technology, and others who were up to this time believed to have a certain interest in 'science'—for Professor Woodward is mistaken if he doubts that the program and classification which he saw has the endorsement of the entire committee. But the kind criticism of Professor Woodward requires the less discussion as he is also mistaken in his second presupposition. He thinks that the classification of sciences which has been accepted for the International Congress was sketched in my article for the purpose of inviting criticism of the scheme. That was not the case. It was merely a communication concerning a settled arrangement, fully discussed and definitely voted by the proper authorities. If I had been longing for criticism, I should hardly have published it in a form which offers merely results and not reasons; and however 'absurd and ridiculous' my system may be, I have at least never evaded the duty to give the reasons and arguments for my positions. A 'scientific man' can not of course read what philosophers and literary folk are writing; otherwise, I might refer him to the first volume of my 'Grundzuege der Psychologie,' in which about 500 pages are devoted to just this discussion; perhaps also to a short essay in the first volume of the 'Harvard Psychological Studies' (Macmillans), where he might find a large map with a tabular view of such classification. There is no doubt that it is more comfortable to 'repudiate' such 'extravagances' than to argue about them; but is it really more 'scientific'?

It is quite different with the very interesting letter from Professor Dewey of Chicago. His letter is full of important arguments worthy of serious consideration. He points clearly to certain dangers in the scheme, and the question is only whether those disadvantages ought not to be accepted in order to gain certain advantages which strongly outweigh them. Every one of the points he raises has been indeed matter for long discussion in the committees, and only after conscientious deliberation have we come to the decisions which he regrets.

As I tried to bring out in my *Atlantic Monthly* article, our real aim is to have a congress which has a definite task and which does not simply do the same kind of work that men of science are attempting every day and everywhere. We do not want, therefore, a bunch of disconnected congresses and in each one a bundle of disconnected papers which could just as well have appeared in the next number of the scientific magazines. We want to use this one great opportunity to work, in a time of scattered specialization, towards the unity of thought. We want to bring out the interrelations of all knowledge and to consider the fundamental principles which bind the sciences together. We want to create thus a holiday hour for science, with a purpose different from that of its workaday functions, an hour of reposeful self-reflection. Therefore, not everybody who would like to be heard could be admitted to the platform, but only those who are leaders in their field, and even these may not speak on their chance researches of the last week, but on definite subjects which all together form one systematic whole. Such a monumental work could be created only under the exceptional conditions of a congress embracing all sciences and all countries, and important enough to attract those who are masters in their work with a wide perspective. This was our aim and this alone our chief claim, as I tried to bring out in my essay, and I see with great satisfaction that Professor Dewey feels in full

harmony with this essential part of the undertaking.

The aspect which he dislikes is this: If we are to invite the leaders of all special sciences, each to consider the relations of his science to the other departments of knowledge, then we must clearly chop the one totality of knowledge into many special parts. That involves at once certain principles of division about which different opinions may exist. We have agreed to recognize 25 different departments with 134 sections, and such decision involves, of course, at once a certain grouping. The sections of the same department stand nearer together than the sections of different departments, and some of those departments again stand in close relations and thus form larger units. We grouped our 25 departments into 7 such chief divisions. Now Professor Dewey says we had no right to do all this, because our classification partly anticipates the work which is to be done by those who are to give the addresses. If each department has from the beginning a definite place on the program, its relations to all other sciences are determined beforehand and it has become superfluous to call in the scholars of the world simply to concur in the committee's ideas concerning the system of knowledge.

But I might ask, what else ought we to have done? I know very well that instead of the 134 sections, we might have been satisfied with half that number or might have indulged in double that number. But whatever number we might have agreed on, it would have remained open to the reproach that our decision was arbitrary, and yet we did not see a plan which allowed us to invite the speakers without defining beforehand the sectional field which each was to represent. A certain courage of opinion was then necessary and a certain adjustment to external conditions was unavoidable; in every case we consulted a large number of specialists. Quite similar is the question of classification. Just as we had to take the responsibility for the staking out of every section, we had also to decide in favor of a certain grouping if we desired to organize the congress and not simply to bring out a helter-skelter performance. Professor Dewey says: "The essential trait of the scientific life of to-day is its live-and-let-live character." I agree with that fully. In the regular work in our libraries and laboratories the year round everything depends upon this democratic freedom in which every one goes his own way, never asking what his neighbor is doing. It is that which has made the specialistic sciences of our day as strong as they are. But it has brought about at the same time this extreme tendency to disconnected specialization with its discouraging lack of unity; this heaping up of information without an ordered and harmonious view of the world; and if we are going to do what we aim at, if we want really to satisfy, at least once, the desire for unity, the longing for coordinations, then the hour has come in which we must not yield to this live-and-let-live tendency. It would mean to give up this ideal if we were to start at once without any principle of organization, ordering the sciences according to the alphabet, perhaps, instead of according to logic. The principles which are sufficient for a directory would undermine from the first the monument of scientific thought which we hope to see erected through the cooperation of the leaders of science. Therefore, some principle had to be accepted. And just as with number of sections, it may be said here too, that whatever principle could have been chosen would probably have had its defects and would certainly have been open to the criticism that it was a product of individual arbitrary decision.

A classification which in itself expresses all the practical relations in which sciences stand to each other is of course absolutely impossible. Professor Dewey's own science, psychology, has relations to philosophy, relations to physiology, and thus to medicine, relations to education and sociology, relations to history and language, relations to religion and law. A program which should try to arrange the place of psychology in the classified list in a way that psychology should become the neighbor of all these other sciences is unthinkable. On the other hand, only if we had tried to construct a scheme of such ex-

aggerated ambitions, should we have been really guilty of anticipating a part of that which our speakers are to tell us. We leave it to the invited scholar to discuss the totality of relations which practically must exist between psychology and other departments of knowledge. We confine ourselves to that minimum of classification which indicates the pure logical relation of the science in the sense of subordination and coordination, that minimum which every editor of an encyclopædic work would be asked to indicate without awakening suspicion of interference with the ideas of his contributors.

The only justified demand which could be made was that we choose a system of division and classification which should give fair play to every existing scientific tendency. And here alone came in the claim which I made for that scheme which has been accepted for the congress. I believed that our classification, more fully than any other, would leave room for every wholesome tendency of our times. I showed that a materialistic system would give fair opportunity to the natural sciences but not to the mental sciences; that a positivistic system would offer room for both mental and natural sciences; but that only an idealistic system has room for all; for the naturalistic and mental sciences, and also for those tendencies which are aiming at an interpretative as well as a descriptive account of civilization. And while we are trying to get, as I said, an organization with a minimum of classification, we were thus trying to provide at the same time for a maximum of freedom. Whatever other principles of classification we might have chosen would have led to an arbitrary suppression of some existing tendencies in modern thought. To use Professor Dewey's illustration: Those students of art, history, politics and education who treat them as systems of phenomena and those who treat them as systems of purposes, alike find in different sections their full opportunity. I have a slight impression that Professor Dewey would have preferred a classification which would have room only for one of the two groups. Our congress will be less partial than our critics. We shall have place and freedom for all.

But there is no reason to speak to-day, as I had to do in May, of a plan for the future. Our undertaking has already a little history. The program has been tried. Then was the moment for the appearance of those destructive effects which Professor Dewey feared. Professor Newcomb, Professor Small and I, who have been honored by the invitation to work as an organizing committee, have just returned from Europe, where we were to bring personal invitations to those who had been selected for the chief addresses. Professors Newcomb and Small visited France, England, Austria, Italy and Russia. I had to see the scholars of Germany and Switzerland. As the Germans have the reputation of being the most obstinate in their scientific ideas, their attitude towards the presented program may be considered as the severest test of it. I had to approach 98 scholars in Germany. Every one saw the full program with the ominous classification of science before he made his decision. Only one third of those whom I invited felt obliged to decline, and among them was not a single one who refused to come on account of the objections foreshadowed by Profesor Dewey. Some can not come because of ill health, some because of public engagements, some on account of the expense, and some because they are afraid of sea-sickness, but not a single one gave the slightest hint that he was disturbed by the limitations which the program might put on him. On the other hand, among those two thirds whom we hope to see here next September, very many expressed their deep sympathy with the plans and the program, and not a few insisted that it was just this which tempted them to risk the cumbersome voyage, while they would have disliked to participate in a routine congress without connected plan and program.

Of course that would not count for much in the minds of my critics, if those who have promised to come and deliver addresses under the conditions of our program were merely 'literary folk who indulge in such extravagances.' I may pick out some of the German

names. For human anatomy there comes Waldeyer of Berlin; for comparative anatomy, Fuerbringer of Heidelberg; for embryology, Hertwig of Berlin; for physiology, Engelmann of Berlin; for neurology, Erb of Heidelberg; for pathology, Marchand of Leipzig; for pathological anatomy, Orth of Berlin; for biology, Weismann of Freiburg; for botany, Goebel of Munich; for mineralogy, Zirkel of Leipzig; for geography, Gerland of Strassburg; for physical chemistry, Van't Hoff of Berlin; for physiological chemistry, Kossel of Heidelberg; for geophysics, Weichert of Göttingen; for mechanical engineering, Riedler of Berlin; for chemical technology, Witt of Berlin, and so on. Or to turn to the department of Professor Dewey: For history of philosophy, Windelband of Heidelberg; for logic, Riehl of Halle; for philosophy of nature, Ostwald of Leipzig; for methodology of science, Erdmann of Bonn; for æsthetics, Lipps of Munich; for psychology, Ebbinghaus of Breslau; for sociology, Toennies of Kiel; for social psychology, Simmel of Berlin; for ethnology, von den Steinen of Berlin; for pedagogy, Ziegler of Strassburg. Or to mention some other departments: Among the philologists I notice Brugman of Leipzig, Paul of Munich, Delitzsch of Berlin; Sievers of Leipzig, Kluge of Freiburg, Muncker of Munich; Oldenberg of Kiel and others. Among the economists, Schmoller of Berlin, Weber of Heidelberg, Stieda of Leipzig, Conrad of Halle, Sombart of Breslau, Wagner of Berlin. Among the jurists, Binding of Leipzig, Zorn of Bonn, Jellineck of Heidelberg, von Lizst of Berlin, Wach of Leipzig, von Bar of Göttingen, Kahl of Berlin, Zitelmann of Bonn, and so on. Among the theologians, Harnack of Berlin, Budde of Marburg, Pfleiderer of Berlin. For classical art, Furtwaengler of Munich; for modern art, Muther of Breslau; for mediæval history, Lamprecht of Leipzig. Enough of the enumeration. The list from England and from France is on the same level, and I anticipate that when we soon shall send out invitations to several hundred Americans for definite addresses, their response will not be less general, their list not less noble. But American participation is a question of the future. The list of acceptances which I have given here stands as a matter of fact beyond discussion. Is there really any doubt still possible that we have secured on the basis of that disastrous program the greatest combination of leaders of thought which has ever been brought together? When we three came home from our European mission after four months of hard labor to secure this result surpassing our own expectations, we might have felt justified in the hope that scientific men of this country would welcome us otherwise than with the cry that we, under the guise of science, have made science ridiculous. HUGO MÜNSTERBERG.

HARVARD UNIVERSITY,
October 12, 1903.

SHORTER ARTICLES.

A PLEA FOR BETTER ENGLISH IN SCIENCE.

THAT to genuine scholarship is not always conjoined power of expression is common knowledge. Not a few men who have received academic training and have been honored with university degrees, who have explored profound mysteries of nature and discovered hidden laws, seem to be incapable of clearly explaining the processes they employ in their researches or of plainly setting forth their discoveries.

Not long ago a contributor to *The Critic* said:

> The development of scientific method is alleged to be one of the foremost characteristics of the present century. Philologists will ransack the earth, if not the heavens, for exact information as to date and authorship of even the fragments of ancient literature; botanists will tramp the forests for months to verify or disprove the rumor of a new orchid, and astronomers will go to any accessible point on the face of the globe for more exact figures on an eclipse or a transit of Venus. We might expect, then, to find a corresponding effort for exactness in the expression of thought, but an examination of the evidence is not altogether encouraging.

A few months ago a Boston editor published the following paragraph:

> The English language is suffering violence in many ways. Among those who are forgetting its

grace and beauty, the elements of its power, and the right use of it, are the students of pure and applied science, who, being eager in youth to get at their work directly, despise such mere scholastic accomplishments as rhetoric, grammar and logic. The result often is that, when they have discovered something which they are eager to give to the world and which the world ought to know, they have no vehicle of language and style worthy to convey their noble facts and great ideas to the public. * * * Many a scientific man has learned in middle life, with bitter regret, that he must take a lower place than he deserves among his fellow-workers because he can not tell what he knows in language that is intelligible and attractive. Others have been hindered in their course, and never knew the reason why.

But worse than inability to write vigorously and pleasingly is the widespread lack of appreciation of clear and precise expression. De Quincey, in his celebrated essay on 'Style,' said, referring especially to professional authors:

Proof lies before you, spread out upon every page, that no excess of awkwardness, or of inelegance, or of unrhythmical cadence, is so rated in the tariff of faults as to balance, in the writer's estimate, the trouble of remoulding a clause, of interpolating a phrase, or even of striking a pen through a superfluous word. The evidence is perpetual, not so much that they rest satisfied with their own random preconceptions of each clause or sentence, as that they never trouble themselves to form any such preconceptions. Whatever words tumble out under the blindest accidents of the moment, those are the words retained.

In his 'Principles of Success in Literature,' George Henry Lewes, referring to the writings of philosophers and men of science, said:

If you allude in their presence to the deplorably defective presentation of the ideas in some work distinguished for its learning, its profundity, or its novelty, it is probable that you will be despised as a frivolous setter up of manner over matter, a light-minded dilettante, unfitted for the simple austerities of science. But this is itself a light-minded contempt; a deeper insight would change the tone, and help to remove the disgraceful slovenliness and feebleness of composition which deface the majority of grave works, except those written by Frenchmen, who have been taught that composition is an art, and that no writer may neglect it.

If these strictures are just, the subject demands attention.

I am well acquainted with the writings, as found in manuscripts submitted for publication, of about one hundred scientists, young, middle-aged and old. One is justified in supposing that on such manuscripts the authors have done their best work. I have classified these authors in three groups: Good, fair, poor—'good' meaning those whose writing is clear, orderly and forcible; 'fair' meaning those whose writing is, indeed, clear and passably methodical, but is not forcible; and 'poor' meaning those whose writing is turbid or chaotic or has other defects which render it of little value, such as extreme verbosity. In the good group fall 19 per cent., in the fair group 57 per cent. and in the poor group 24 per cent. That is to say, neglecting such formal bagatelles as the split infinitive, and merging the details of purity, propriety and precision in the larger qualities, I find that fewer than one fifth of these authors write with clearness, method and force, and that almost one fourth of them do not write even clearly.

Into this evaluation there enters, of course, whatever weakness may reside in my individual judgment. I am sure, however, that the finding is not vitiated by prejudice or favoritism, conscious or unconscious; and in making the assignments to the three classes I gave every author the benefit of a doubt.

Of these men about 75 per cent. have had collegiate or university training; their almæ matres are our leading universities and schools of science. No fewer than twenty of them are now professors or instructors in such institutions of learning, and most of these fall in the fair class: their writing is not strong. In a few cases it is markedly weak; in other cases there is manifested an abundance of energy, but it is not under good control. In the good class there is at least one who is self-educated. Thus it appears that scientific and university life, with the

preparation in lower schools which this implies, does not insure good English.

If the results given seem somewhat depressing, let us take courage from the Frenchman who declared that 'it needs more delicate tact to be a great writer than a great thinker,' and inquire whether, after all, the condition presented is markedly exceptional.

It is probable that if any other large body of writers were similarly classified they would not make a much better showing. My evaluation, unlike that of the writers quoted, is of *manuscripts* as they are received from the authors. Literature of belletristic character, having little if any immediately practical or economic content, is necessarily dependent for existence upon its intrinsic merit and must be at least fair if it is accepted for publication. On the other hand, many abominably written scientific papers are so richly laden with the results of observation and experiment that they are given prompt publication—so prompt that they can receive but a modicum of editorial attention. That is to say, nearly everything written by men of science is published, whereas only the supposed cream of 'polite' productions is thus honored. If practically all that is written in the line of novels, of essays or of poetry were published, the 'poor' percentage would doubtless be higher than twenty-four.

Although, therefore, scientific writing, relatively considered, is not in a desperate plight, its condition is bad enough and is, I believe, susceptible of no little improvement. Recognizing that the able writer is born rather than made—that the chief requisites are, as Herbert Spencer has said, a sense of logical dependence, constructive ingenuity, a good verbal memory and a sensitive ear, and that these qualities are largely innate—I nevertheless believe that in many cases the ability is present but is never used; it lies dormant, and could be awakened and brought into service. What it needs is appreciation and utilization. "In England and Germany," says Lewes, "men who will spare no labor in research, grudge all labor in style; a morning is cheerfully devoted to verifying a quotation by one who will not spare ten minutes to reconstruct a clumsy sentence; a reference is sought with ardor, an appropriate expression in lieu of the inexact phrase which first suggests itself does not seem worth seeking. What are we to say to a man who spends a quarter's income on a diamond pin which he sticks in a greasy cravat?" One can hardly escape the conviction that this criticism applies to America as well as to England and Germany.

It is true that, according to the figures, a large majority write clearly, but clearness alone is not sufficient. Sentences and paragraphs may themselves be perfectly clear, but the ideas they clothe be so inconsequent if not inconsequential, that their total effect on the reader is weariness. Effective composition implies sequence and unity, symmetry and proportion. Vital writing, whether it be a sentence, a paragraph or a disquisition, is characterized by structure and integrity. Such are the famous paragraphs of Macaulay, whose 'astonishing power of arranging facts and bringing them to bear on any subject * * * joined with a clear and vigorous style,' says McMaster, 'enabled him to produce historical scenes with a grouping, a finish and a splendor to which no other writer can approach'; such are the exquisite essays of Lowell, who 'added to the love of learning the love of expression'; and such are the philosophical dissertations of Herbert Spencer, whose power of presentation is remarkable. Schopenhauer classified authors into three kinds: "First," said he, "come those who write without thinking. They write from a full memory, from reminiscences. This class is the most numerous. Then come those who do their thinking while they are writing, and there is no lack of them. Last of all come those writers who think before they begin to write; they are rare." If Addison's definition of good writing (a definition which was warmly endorsed by Hume)—that it consists in the expression of sentiments or ideas which are natural but not obvious—is valid, it is apparent why the productions of authors who fall in the first class are poor: the lucid statement of relations which are not obvious

requires thought. Papers by writers of this class are inevitably amorphous and weak. If those by the second class do exhibit power, the power is apt to be lawless, and the tectonics are likely to be distractingly apparent to the reader. Only papers by the third class can possess structure and grace. Schopenhauer declares further that an author's style is an exact expression of his mode of thought; that it shows the formal nature—which must always remain the same—of all the thoughts of a man; and, therefore, that when he has read a few pages of an author, whatever the subject, he knows about how far that author can help him. Similarly wrote Dean Alford in his 'Plea for the Queen's English': "If the way in which men express their thoughts is slipshod and mean, it will be very difficult for their thoughts themselves to escape being the same."

Again, effective composition implies concentration, distillation, a process akin to chemical rectification; and this it is that energizes. Josh Billings said: "I don't care how much a man talks if he only says it in a few words." Lecky calls this power the supreme literary gift of condensation, which Gibbon possessed in so high degree. In the case of a talented writer this process is subconscious and rapid, but others achieve the result through conscious effort if not downright labor. Macaulay made almost endless changes, both of matter and of style. Said Joubert: "If there is a man tormented by the accursed ambition to put a whole book into a page, a whole page into a phrase, and that phrase into a word, it is I." Little wonder that Joubert has succeeded La Rochefoucauld as the most famous coiner of aphorisms. John Burroughs has lately said, in his 'Literary Values': "There is a sort of mechanical equivalent between the force expended in compacting a sentence and the force or stimulus it imparts to the reader's mind. * * * So much writing there is that is like half-live coals buried in ashes—dead verbiage." Spencer, in his essay on 'The Philosophy of Style,' observes that the strongest effects are produced by interjections, which condense entire sentences into syllables, and that signs are still more forcible. For instance, to say 'Leave the room' is less expressive than to point to the door. Doubtless science would make slow progress if obliged to use the sign language; yet in the prolixity and tenuity which characterize much of the scientific writing of the day there is no progress, but only vexation of the spirit of the reader. "It is with words as with sunbeams," says Saxe, "the more they are condensed the deeper they burn." In sententiousness there is strength. We feel it in the epigrammatic sentences of Emerson, who wrote to Carlyle of 'paragraphs incompressible,' and most of whose titles are single words. On the other hand, some of Kant's sentences have been measured by a carpenter and been found to run two feet eight by six inches. "A sentence with that enormous span," says De Quincey, "is fit only for the use of a megatherium."

As an example of scientific writing which is not only clear and methodical, but forcible, I may mention that of the late George H. Williams, in whose untimely death the scientific world suffered a loss.

That clearness and force are desiderata in scientific writing will be admitted by all. It may be somewhat rash, however, even to mention in such connection a higher quality; but I observe that into this article the words 'grace' and 'beauty' have already crept and I am not disposed to cancel them. Says Joubert: "In the mind of certain writers nothing is grouped or draped or modeled; their pages offer only a flat surface on which words roll." Says Lewes: "A man must have the art of expression or he will remain obscure." Says Buffon: "Only well-written works will survive; abundance of knowledge and singularity of facts are not a guaranty of immortality."

Rhetoric, we know, was to Huxley an abomination—a vile cosmetic; yet it is not difficult to discover in Huxley's writings pages that are rhetorically elegant. The fact that with him the action was spontaneous is merely evidence of his artistic endowment; and there can be no doubt that his shafts were hurled at the foolishness of literary foppery, not at

that natural grace of style which, like elegance of manners, can be felt but not analyzed. Doubtless the technical description of a dinosaur or of an aboriginal shell-heap can derive little aid from metonymy or climax; but the field of the scientific specialist merges insensibly in common ground, and when he is on the borders he is within view of the whole world of letters. Moreover, the man of science often takes literary excursions into neighboring provinces—at least many of the great men of science do. Witness Huxley himself, with his 'Lay Sermons'; and John Tyndall, who almost made a specialty of feeding 'Fragments' to the unscientific, and whose fame is due chiefly to his brilliant advocacy, oral and in writing, of physical science; and Ernst Haeckel, with his 'Riddle of the Universe.'

"The importance of style," says Lewes, "is generally unsuspected by philosophers and men of science, who are quite aware of its advantage in all departments of *belles lettres*. * * * Had there been a clear understanding of style as the living body of thought, and not its 'dress' * * * the error I am noticing would not have spread so widely. The matter is confluent with the manner, and only through the style can thought reach the reader's mind." Here Lewes but repeats De Quincey, who cites Wordsworth to the effect that it is the highest degree unphilosophical to call language or diction 'the dress of thought'; Wordsworth would call it the *incarnation* of thought. 'Never in one word,' says De Quincey, 'was so profound a truth conveyed.'

Of the authors whose writings I have classified as 'good,' there are five or six whose writings I should place in the highest class, that of excellent; for to the characteristics of clearness, orderliness and forcibleness they add the final quality of elegance or attractiveness. As an example of scientific writing of this class, mention may be made of that of the late Dr. John S. Newberry. If one doubts it one should read his paper on 'The Ancient Lakes of Western North America,' in the Fourth Hayden Annual.

Scientific men, especially the young men, are prone to spend most of their time in observing and experimenting; comparatively little is devoted to studying the accumulated data and their relations, and little indeed is reserved for composition. Phenomena are sought with eagerness, but, once discovered, interest in them wanes. The field and the laboratory are too alluring to be resisted for long, and the time to be devoted to reflection and to writing is minimized. Neglecting what Coleridge termed 'ratiocinative meditation,' they produce with facility papers consisting of crude raw materials which can but repel persons endowed with a sense of order, strength and beauty. Doubtless these writers are, as Henry James says, 'strangers to the pangs and the weariness that accompany the sense of exactitude, of proportion and of beauty,' but in many cases it is also true that they are writers who 'have been hindered in their course and never knew the reason why.' I appeal to the scientific men of America, especially the younger men, to cast off this shameful indifference to the power and beauty of their marvelously rich and adaptable language, and to devote to their writing some of the energy they manifest in the field and some of the patience they exercise in the laboratory.

In a recently issued university catalogue, under the heading 'Admission' and the subheading 'English,' appears the following item of gratifying information: "The candidate should read all the prescribed books, but knowledge of them will be regarded as less important than ability to write English." That a young man entering on a scientific course at a university should have read carefully 'Silas Marner' and 'The Sir Roger de Coverley Papers' is doubtless desirable, but that he should be able to express, in English that is at least clear and vigorous, whatever he may know on any subject is of far more importance. Without the property of reversibility, giving the motor, the dynamo-electric machine would lack the greater portion of its usefulness. Though a man be surcharged with knowledge, his usefulness to mankind must be slight unless he is able to

impart the knowledge through the medium of clear and forcible language; and there are indications that both the preparatory schools and the universities are awaking to a realization of this fact.

P. C. Warman.

A CONTRIBUTION TO THE CRANIOLOGY OF THE PEOPLE OF SCOTLAND.*

Under this title Professor Sir William Turner, than whom no one is better qualified to deal with this subject, presents the first systematic account of the cranial characters of the people of Scotland. The study is based on 176 carefully gathered skulls (117 males and 59 females) obtained principally in the counties south of the Clyde and Tay ('lowland Scotland').

The memoir is written in the same clear style, eminently fit for instruction, which marks all the works of this author, and the results of the study are of much interest. These results are briefly summarized as follows:

"The Scottish cranium is large and capacious; the vertex is seldom heeled or roof-like, but has a low rounded arch in the vertical transverse plane at and behind the bregma." The side walls "bulge slightly outwards in the parieto-squamous region, so that the greatest breadth is usually at or near the squamous suture. The occipital squama bulges behind the inion." The glabella and supraorbital ridges, in men, 'are fairly but not strongly pronounced, the forehead only slightly recedes from the vertical plane and the nasion is scarcely depressed.'

From the "analysis of the cephalic indices, it would appear that a brachycephalic type of skull prevailed in Fife, in the Lothians, in the northeast counties of Forfar, Kincardine and Banff; and it occurred to some extent in Shetland, in Ayr, in the border county of Peebles, and in Stirlingshire."

"The dolichocephalic type of skull was feebly represented in Fife; it was proportionally more numerous in the Lothians; it was represented in Lanark, Ayr, Shetland and the Hebrides. It formed the prevailing type in Wigtonshire, in Caithness, in the skulls from the Highland counties, and in the important series of skulls from Renfrewshire."

The vertical diameter—basion-bregma—(mean, in males, 132.4 mm.), was only in two out of 150 of the Scottish crania in which the measurement would be taken in excess of the breadth; the two measurements were equal in four others, while 'in all the rest, whether cephalic index was high or low, the vertical diameter was less than the breadth.' 'The Scottish skulls are platychamæcephalic.'

Among the 73 male and 42 female crania that were cubed (with shot, according to Turner's method), 'the maximum capacity in the male skulls was 1,855 c.c., the minimum was 1,230 c.c., and the mean was 1,478 c.c.'; 'the maximum in the female was 1,625 c.c., the minimum 1,100 c.c. and the mean 1,322 c.c.' Apparently the Scottish male skull is 'somewhat in excess of the mean ascribed to the crania of European men.' The female skull, similarly as in other races and people, is about ten per cent. less capacious than the male.' 'In twenty-five male dolichocephalic crania the mean capacity was 1,516 c.c.'; in twenty-one male crania of cephalic index 'from 75 to 77.4, the mean capacity was 1,519 c.c.'; in fifteen with cephalic index of '77.5 to 79.9, the mean capacity was 1,452 c.c.'; and 'in thirteen brachycephalic skulls the mean capacity was 1,469 c.c.' The Scottish skulls 'with dolichocephalic proportions had a distinctly greater mean capacity than the brachycephalic.'

The highest mean cranial capacity was given in the males, 'by the skulls from Fife, Mid-Lothian, Shetland and Renfrewshire'; while the mean was lowest in the skulls 'from Edinburgh and Leith, West Lothian, the northeastern counties, the highland counties and the dissecting-room.'

"The face was usually orthognathous, sometimes mesognathous; the nose was prominent, long and narrow, leptorhine; the orbits had usually the vertical diameter high in relation to the transverse, mesoseme or megaseme; the

* *Trans. Roy. Soc. Edinburgh*, Vol. XL., Part III., No. 24, 1903.

face was high in relation to the width, leptoprosopic." "The lower jaw had a well-defined angle, the body of the bone was massive in the males, and with a pronounced chin."

So much for this first memoir, which leaves to be desired only greater numbers of specimens from some of the counties and, especially with the relation to cranial capacity, estimates of height of the individuals. A second memoir, to contain an account of prehistoric Scottish skulls, as well as 'a discussion of the character of Scottish crania and heads in their general ethnographical relation to prehistoric races in Britain, and to the people of the adjoining part of the continent of Europe' is to follow.

A. Hrdlicka.

U. S. National Museum,
Washington, D. C.

VERTEBRATE PALEONTOLOGY AT THE CARNEGIE MUSEUM.

Through the continued generosity of Mr. Carnegie the usual activity has been maintained during the past year in the Department of Vertebrate Paleontology at this museum.

The Bayet Collection of Fossils.—Negotiations begun more than a year ago by the present writer resulted in July in the acquisition of the paleontological collections of Baron de Bayet of Brussels, Belgium. This collection is especially rich in Mesozoic vertebrates from Solenhofen, Cerin, Holzmaden, Lyme Regis and the province of Benevento, Italy; in Tertiary fishes and other vertebrates, invertebrates and plants from the famous locality of Monte Bolca, near Verona, Italy; from Armissan, near Narbonne, France; from the Belgian Tertiaries; from Sicily, etc. It also contains large and valuable collections of insects and other invertebrates from the Solenhofen beds of Bavaria, a superb collection of European cephalopoda from the Mesozoic and of Paleozoic trilobites and other invertebrates.

Though containing no types and little that is new to paleontology, its acquisition by an American museum is of importance as making accessible for the first time to American students any considerable collection of European vertebrates without the necessity of a trip to Europe. Dr. C. R. Eastman has undertaken to prepare a memoir descriptive of the fishes in the collection, and it is the desire of the curator of the department to arrange for the treatment of the other groups in a similar manner by equally competent specialists, so that the material in the collection may be made known and available for purposes of comparison to students of paleontology.

It will doubtless be many years before a similar opportunity will present itself for acquiring at a single stroke so large and varied a collection of European fossil vertebrates, and American paleontologists are indebted to Mr. Carnegie for his generosity in supplying the funds necessary for the purchase of this valuable collection.

Field Work during the Season of 1903.—During the season just drawing to a close four parties have been engaged, under the general direction of the curator, in studying the geology and in collecting vertebrate and other fossils from various Tertiary, Mesozoic and other horizons of the west, chiefly in Kansas, Wyoming and Montana.

Pursuant to a general plan undertaken some time since, Mr. Earl Douglass has continued his explorations of the Tertiary lake basins of western Montana and has been successful in securing considerable collections representative of the fossil faunas and floras of those deposits. Of greatest importance among the results of his labors in that region may be mentioned the discovery of Oligocene beds referable to the White River and containing the remains of a rich and varied vertebrate fauna in a good state of preservation. Heretofore the White River formations of that region have yielded comparatively few and for the most part poorly preserved vertebrates. In addition to his work in the Tertiary Mr. Douglass was also able to make some interesting collections from, and observations relating to the Carboniferous and Permian(?) of that region.

During the earlier part of the season Mr. C. W. Gilmore was engaged in completing the

work in a Jurassic dinosaur quarry opened by him during the preceding season at the base of the Freezeout Mountains in southern Wyoming. After successfully completing this work he began, early in June, explorations in the chalk (Niobrara) of western Kansas, where he was joined by Dr. E. H. Sellards as assistant. It is the earnest desire of the curator of this department that the paleontological collections of the museum shall eventually represent in a creditable manner the faunas of all the more important fossil-bearing horizons of our own country at least. It was with the idea of acquiring such a representative collection of Niobrara fossils that the work in Kansas by Mr. Gilmore and Dr. Sellards was undertaken. Already some forty-five boxes of material have been collected and we hope to continue the work in this formation for some years.

Mr. W. H. Utterback completed the unearthing of the splendid skeleton of *Diplodocus,* discovered by him the preceding year in the Jurassic deposits on the Red Fork of Powder River at the foot of the Big Horn Mountains in central Wyoming. In this same region he also secured considerable portions of the skeletons of two other colossal Jurassic dinosaurs. In the latter part of August Mr. Utterback was transferred to central Montana to continue the work in the Cretaceous of that region carried on during the month of August by the present writer. In this field considerable new and interesting material has been discovered, coming chiefly from the Judith River beds.

Research Work.—In research, beside several shorter papers by the curator, Mr. Douglass and Mr. Gilmore, there have appeared or are now in press an important paper by Mr. Douglass on the vertebrate fauna of the Tertiary lake beds of Montana (*Annals Carnegie Museum,* Vol. 2, pp. 145–199 with Plate and 37 figures in the text); a paper by the present writer on the 'Oligocene Canidæ' (*Memoirs Carnegie Museum,* Vol. I., No. II., pp. 65–108, 6 plates and 7 figures in text) and another by the same author on the 'Osteology of *Haplocanthosaurus*' (*Memoirs Carnegie Museum,* Vol. II., No. I., pp. 1–75, 6 plates and 30 figures in text).

The most important additions to the exhibition series during the year have been the skeleton of *Daphœnus felinus* mounted by Mr. A. S. Coggeshall and the skeletons of a Loup Fork camel and of an Oligocene sabre-toothed cat (*Hoplophoneus*) mounted by Mr. O. A. Paterson. Two splendid skeletons of *Ichthyosaurus* have also been placed on exhibition.

Considerable progress has also been made in the preparation of casts of the skeleton of *Diplodocus carnegii* for exchange with other museums.

J. B. Hatcher,
Curator Vertebrate Paleontology.

Carnegie Museum,
October 6, 1903.

ETHNOLOGICAL AND ARCHEOLOGICAL SURVEY OF CALIFORNIA.

For several years the University of California, through its Department of Anthropology and by the liberal assistance of Mrs. Phoebe A. Hearst, has been engaged in an Ethnological and Archeological Survey of the State. A large amount of material, illustrative of Indian life and culture in past and present times, has been obtained and will form an important part of the anthropological collections which will in the future be exhibited in a museum of the university at Berkeley. At the present time this collection, with others of the department, is temporarily placed in one of the buildings of the affiliated colleges belonging to the University in San Francisco. Here the large and valuable collections are safely cared for until the permanent museum building is secured.

Systematic explorations are being made of the later gravel deposits, of several caves, and of the ancient shellheaps, in order to ascertain when man first occupied this region. The languages of the existing Indians are being studied by experts of the department; the customs and mythology of the different tribes are being carefully recorded; and collections illustrating their arts are being formed for the museum. A study of the physical characters of the various groups of Indians, combined

with that of the skeletons found during the archeological explorations, is being made in order to determine the physical relations of the Indians of California with those of other regions. By correlating the physical characters, the particular cultures of the past and present Indians, and the various linguistic stocks or families still extant, it is hoped to solve the great problem of the relationship of the numerous groups of Indians in California, and their relationship with peoples of other parts of the continent and possibly with certain tribes of Asia.

Nowhere in America has there been such a diversity of Indian languages as in California, a condition which has long puzzled anthropologists. During the past five years more investigations of these languages have been made by the University and by eastern institutions than in all previous time. These Indian languages are now fast disappearing. Several are at the present moment known only by five or six, others by twenty or thirty individuals, and hardly a year passes without some special dialect, or even language, becoming extinct. For this reason it is desired that students should be instructed in the methods of recording and studying Indian languages, and then devote themselves to special research. The University is, therefore, giving instruction in this branch of linguistics with the hope of preparing students to carry on the research before the opportunities pass away. Similar reasons apply to researches in other divisions of ethnology, and in archeology; hence the training of students in these subjects is also undertaken by the Department of Anthropology.

The officers of the department make a special appeal to persons in all parts of the State and adjacent regions for aid in this survey. Hundreds of Indian objects are found annually, which if carefully labelled as to where and how found and sent to the university, would, when brought together for comparative study, aid in the settlement of many important questions. The distribution of a particular kind of stone implement or of an ancient form of basket, and of many other objects of Indian manufacture (even the peculiar stone of which an implement is made is of great importance), will aid in determining the distribution of a tribe or group of which other records may be lost or so uncertain that just such confirmatory evidence to establish a particular point is required.

Information relating to the location of caves, shellheaps, old burial places, ancient village sites, and scattered fragments or survivors of nearly extinct tribes, is earnestly solicited, that such may be investigated by the department and may be correctly recorded on its ethnological and archeological maps of the State.

The university is by this survey carrying on a research of great importance in obtaining a knowledge of the first peopling of the Pacific Coast and of the early migrations, and of the relationships of the recent and present Indians, a research that is required by anthropologists and by all interested in the early history of man. This work has been well begun, but assistance of many kinds is needed for its progress. This assistance it is hoped will be given to aid the University of the State in an undertaking of such general interest.

Two volumes of the publications of the department, relating to the languages, myths and customs of certain tribes of California, are now in press and are to be followed by others as the material is prepared.

Correspondence leading to aid in this survey is solicited by the Department of Anthropology of the University of California.

Benj. Ide Wheeler,
President of the University.
F. W. Putnam,
Director of the Department of Anthropology.
Berkeley, California,
October 15, 1903.

SCIENTIFIC NOTES AND NEWS.

Professor Raphael Pumpelly, of Newport, R. I., has recently returned from a summer's journey in Turkestan, where he made a reconnaissance under the auspices of the Carnegie Institution of the ancient human occupation of the region in relation to its physiography. The other members of the expedition were Professor W. M. Davis, of Harvard; Mr.

Ellsworth Huntington, Carnegie research assistant, and Mr. R. W. Pumpelly, with Mr. S. de Brovtzine of St. Petersburg as interpreter. Mr. Richard Norton, director of the American School of Classical Studies in Rome, was an independent member of the party. From Baku, the great petroleum port on the west coast of the Caspian, the travelers crossed by steamer to Krasnovodsk May 23, whence the Central Asiatic railway carried them, with many stops and side excursions on the way, to the end of the main line at Tashkent and to the end of a branch line at Andizhan June 26. Professor Pumpelly, with Messrs. Norton and Pumpelly, then made an excursion southeastward across the Alai range and valley to Lake Karakul on the northern Pamir, returning *via* Andizhan, Baku and Constantinople, and reaching America on September 4. Professor Davis and Mr. Huntington went northeast, crossing the western Tian Shan ranges to Lake Issikul, where they separated; Professor Davis turned northward and came home *via* Semipalatirsk, Omsk and St. Peterburg; Mr. Huntington went south to Kashgar and west to Samarkand and Aschabad, where he has lately arrived and where he will make his winter headquarters after an excursion into northern Persia.

The Research Laboratory of Physical Chemistry at the Massachusetts Institute of Technology, the establishment of which was announced in Science for June 5, 1903, was opened on September 20 with a staff of eight research associates and assistants and two graduate scholars working under the direction of Professors A. A. Noyes, H. M. Goodwin and W. R. Whitney. The following investigations are already in progress: 'The Electrical Conductivity of Aqueous Solutions at High Temperatures (up to 306° and higher),' three separate researches carried on by Dr. W. D. Coolidge, Dr. H. C. Cooper and Mr. A. C. Melcher; 'The Conductivity of Fused Salts,' by Mr. R. Haskell; 'Electrical Transference Determinations with Nitric Acid,' by Mr. Y. Kato; 'The Migration and Coagulation of Colloids,' by Dr. J. C. Blake; 'The Equilibrium in Solution between Milk Sugar and Its Hydrate,' by Mr. C. S. Hudson; 'The Dissociation-Relations of Sulphuric Acid at Various Temperatures,' by Mr. M. A. Stewart; 'The Hydrolysis of Ammonium Sulphide determined by Vapor Pressure Measurements,' by Mr. C. F. Sammet. The researches upon the conductivity of aqueous solutions and upon transference are assisted by grants made to Professor Noyes by the Carnegie Institution. Besides these physico-chemical investigations, work is being continued with the assistance of Mr. C. S. Bryan in developing a new system of qualitative analysis which shall include nearly all the rare metallic elements.

At the ceremonies attending the installation of the Rev. Dr. Gordon as principal of Queen's University, Kingston, Ont., the degree of LL.D. was conferred, among others upon Dr. J. E. Creighton, professor of philosophy at Cornell University, and Dr. Victor Goldschmidt, professor of mineralogy, Heidelberg University, Germany.

The Harvard correspondent of the *Evening Post* states that the Hon. William H. Moody, secretary of the Navy, and Mr. Gifford Pinchot, chief of the Bureau of Forestry, will speak at a meeting of the members of Harvard University on November 2, under the auspices of the Political Club, a non-partisan organization of students organized to promote interest and active participation in politics on the part of university men. Secretary Moody's subject will be 'The Administration of the Navy,' and Mr. Pinchot's 'The Opportunities in the Government Scientific Departments.'

Dr. Edgar J. Banks has been given charge of the archeological excavations to be undertaken near Bysmias by the University of Chicago with the permission of the Turkish government.

P. G. Nutting, A.B. (Stanford), Ph.D. (Cornell), has been appointed to a position in the National Bureau of Standards.

Dr. L. Messerschmidt has been appointed assistant to the director of the Royal Museum in Berlin.

A COURSE of lectures on tropical medicine will be given at the Jefferson Medical College by Capt. Charles F. Kieffer, assistant surgeon, U. S. Army. The lectures will be given at 4 P.M. each Monday in the amphitheater of the hospital.

ACCORDING to a cablegram to the daily papers, Mr. L. A. Fischer, of the National Bureau of Standards, has compared the American meter with the international standard and has found it accurate. Mr. Fischer is investigating the systems of weights and measures of European countries with the view of drawing up a report upon which Secretary Cortelyou, of the Department of Commerce and Labor, will make recommendations to Congress.

THE Stockholm correspondent of the London *Morning Advertiser* says that the Academy of Science proposes to confer the Nobel prize for physics on Mr. William Marconi.

A MONUMENT is to be erected at Brussels as a memorial to Zenobe Gramme, known for his work in electricity. M. Léon Janssen is chairman of the committee in charge.

AN obelisk of unpolished grey granite has been placed over Virchow's grave in the old Matthäi graveyard, Berlin. It bears on one side a black marble tablet, on which is inscribed 'Rudolph Virchow,' and the date of his birth and death. A statue of Virchow will also be erected near the place where his scientific work was conducted.

PROFESSOR ALEXANDER ROLLETT, of Graz, known for his researches in the physiology of blood and muscles, died on October 1, in his seventieth year. The death is also announced of M. G. R. Dahlander, professor in the Polytechnic Institute at Stockholm.

THE *Bulletin of the American Mathematical Society* states that the Carnegie Institution has in preparation, under charge of the librarian of Congress, a handbook of learned societies and institutions, which is to contain various information of importance to scholars, but not hitherto published in convenient form.

THE Marconi system of wireless telegraphy has been put in operation between Peking and the coast.

IT is said that Dr. August Greth of San Francisco, who had put his small savings into an airship of crude construction, sailed about over that city on October 18, apparently having full control of his machine. While sailing to the Presido his power, furnished by a six horsepower gasoline engine, failed him, and he descended into the water of the bay. Money has now been offered him to build a better machine.

THE third annual intercollegiate geological excursion in New England was held at Meriden, Conn., on Saturday, October 17, under the guidance of Professor Gregory of Yale University. The geological profit of the excursion was unfortunately interfered with by fog on West Peak of the Hanging Hills, and by several heavy showers in the valley; nevertheless the general structure of the region was pointed out, the double lava flow in the Meriden quarry was well seen and several of the faults by which the district is divided into long, narrow blocks were demonstrated. The largest delegations of students were from Yale University, under Professors Gregory, Pirsson and Barrell, and from Wesleyan University under Professor Rice. Harvard, Wellesley, Amherst, Smith and Williams were also represented, as well as a number of secondary schools. Over one hundred persons took part in the excursion.

THE *Zoological Society Bulletin* states that the end of the next twelve months will reveal an important advance in the development of the New York Zoological Park. The Antelope House and its twenty-two yards outside will be ready for use about November 1. The building of an Ostrich and Cassowary House, 170 feet long, has been begun and also the erection of a Small Mammals' House, 170 feet long. A contract for the large Bird House was awarded on September 14. Plans for a large Deer House are now in course of preparation. The Llama House is ready for use and the entire collection of animals arrived about October 1 as the gift of Mr. Robert S. Brewster. The visitors to the Park during the month of August numbered 155,000, an increase of 29,000 over the records of

the previous year. The largest attendance so far was on Sunday, September 16, amounting to 35,667 persons.

THE director-in-chief and other members of the staff of the New York Botanical Garden will be pleased to receive members and their friends at the grounds in Bronx Park on every Saturday in October and November. Train leaves Grand Central Station, Harlem Division, N. Y. C. R. R., at 2:35 P.M., for Bronx Park. Returning train leaves Bronx Park at 5:32 P.M. Opportunity will be given for inspection of the museums, laboratories, library and herbarium, the large conservatories, the herbaceous collection, the hemlock forest and parts of the arboretum site. The walk planned will be a little over a mile. Lectures will be given in the museum building at 4:30 o'clock, as follows:

October 3, 'The Botanical Exploration of the West Indies,' by Dr. N. L. Britton.

October 10, 'Some Aspects of Tropical Agriculture,' by Professor F. S. Earle.

October 17, 'Some Features of Jamaican Vegetation,' by Professor L. M. Underwood.

October 24, 'Features of the Land and Marine Flora of Porto Rico,' by Dr. M. A. Howe.

October 31, 'Explorations in Hayti, the Negro Republic,' by Mr. G. V. Nash.

November 7, 'Mountains and Forests of Dominica,' by Professor F. E. Lloyd.

November 14, 'Beverages of Vegetable Origin,' by Professor H. H. Rusby.

AMONG the lectures to be given this season before the Royal Institution, London, are the following:

'The Present Position of English Commerce,' by Lord Avebury, F.R.S.

'The Work and Aims of the London University,' by Sir Arthur W. Rücker, F.R.S.

'The Brains and Minds of Animals,' by Alex. Hill, Esq.

'Persia and the Persian Gulf,' by J. D. Rees, Esq.

'Radium and the Periodic Law in connection with Recently Discovered Elements,' by Sir William Ramsay, F.R.S.

'Volcanoes, with special reference to the recent eruptions,' by Professor E. J. Garwood.

'Balloons and Flying Machines,' by J. M. Bacon, Esq.

'The Ice-Breaker *Ermack*,' by Arthur Gulston, Esq.

"Mars and its 'Canals,'" by E. Walter Maunder, Esq.

'1. Ice, 2. Water, 3. Steam,' by Dr. William Hampson, M.A.

'Mexico and its Natural History,' H. F. Gadow, Esq. F.R.S.

'The Food of the People,' by Robert Hutchinson, Esq.

'The Crustacean Question,' by Professor G. B. Howes, F.R.S.

'The Measurement of the Heavens,' by J. D. McClure, Esq.

ACCORDING to the latest bulletin of the Health Department of Chicago, the remarkable decrease in the mortality of children less than one year old that has taken place since 1891 —a decrease of 60.1 per cent.—is due not so much to an improved milk supply, the antitoxin treatment of diphtheria and other causes often cited to account for it, as to the work of woman's clubs and similar organizations in the education of mothers in the hygiene of the young. This, it is believed, is the principal factor in giving the baby a better chance for life.

THE New York *Times* states that the board recently organized to consider and report upon the subject of engineering instruction and training for officers of the line of the navy, of which Captain George A. Converse is the senior member, recently held its first session in New York. The recommendations contained in the order convening the board were talked over, and, while no definite outline was determined upon, it was concluded that the subject is one of large scope, which will require careful study and preparation. Undoubtedly there will be established an engineering school for officers, and this may, perhaps, be located at the Naval Academy at Annapolis, using the engineering experimental station recently established at that place. Congress at its last session created this experimental station upon the recommendation of Rear Admiral George W. Melville, head of the Bureau of Steam Engineering of the Navy Department, who advocated the idea for several years before his efforts were successful. The board expects that it will take at least six months for it to prepare and outline a proper course of

instruction for the new school. The board has decided to hold its sessions in Washington hereafter.

Dr. Frederick Rose, British consul in Stuttgart, has lately prepared a series of reports on technical education of various kinds in Germany, which have been issued from time to time by the Foreign Office. The latest of these deals with instruction in forestry and the present condition of forest economy. According to the abstract in the London *Times*, he describes the preliminary educational and other qualifications demanded from students, and then proceeds to explain the organization and course of instruction at Eberswalde, in Prussia, Aschaffenburg, in Bavaria and Karlsruhe, in Baden, as well as the subsequent prospects of the qualified students in the different states, in order to show what forestry as a profession is in Germany. He then takes the kingdom of Würtemberg as an example of the economical benefits of the scientific management of forests, and from this estimates the annual value of the forest products of the Empire. Some of his statements on this subject will be of interest. Out of the total of 135 million acres forming the German Empire, about 35 million consist of forests or forest lands. Rather more than half of this consists of purely forest holdings, the remainder being attached to agricultural holdings. Baden has the largest relative area of forests; the proportion of the whole area of the State being 40 per cent., while in Prussia it is 25, in Bavaria 33 and in Würtemberg 30 per cent. The oak is chiefly grown on the Lower Rhine and in Westphalia, the beech in Pomerania, the fir in South Germany, the pine on the Central German hills, the Scotch pine on the plains of northeastern Germany, while the low-lying lands everywhere grow the elm, ash, beech, oak and birch. The Scotch pine is the most widely cultivated of any tree, the pine and fir and the beech coming next in extent of area covered. The annual revenue derived from forests in Germany is estimated at 15 to 18 millions sterling; in regard to Würtemberg the precise figures are known. This state possesses 1½ millions of acres of forests, the produce of which in 1900 yielded £1,700,000; the cost of production was £500,000, leaving a profit of £1,200,000, or about 16s. an acre. If the taxation be deduced from this, there is a clear profit of 14s. an acre. Statistics given by Dr. Rose show a steady annual increase in the value per acre of forest produce since 1860, which amounts in the cases of Prussia, Saxony and Würtemberg to as much as 80 per cent. The report concludes with some interesting observations on the importance to a nation from various points of view—sentimental, esthetic and hygienic, as well as economical—of its forests.

The Royal Society of New South Wales held a conversazione on August 27. The exhibits included the following: Mr. R. T. Baker, exhibits from Technological Museum; Mr. Henry Deane, models of the new Central Railway station: clock tower, smaller tower, arrival bridge, general view; His Honor Judge Docker, stereoscope and set of stereographs of Tasmanian scenery; Geological Survey, N. S. Wales, framed photographs of N. S. Wales geology, meteorite and casts from Gilgoin Station, N. S. Wales, miscellaneous minerals; Mr. W. M. Hamlet, microscope showing metallic structure by etching methods now used in metalloscope, microscopes; Mr. H. L. Jones, Clark automatic telephone switchboard, model of modern bogey frame with wheels, used on heavy railway tracks in the United States; Mr. J. H. Maiden, copies of plans of the botanic gardens and government domains from 1807 to 1880; Mr. Ernest W. Warren, physical apparatus—vacuum tubes, X-Rays, high frequency apparatus, induction coils, etc.

Dr. F. Henrotin writes to the *Journal of the American Medical Association* that Rush Medical College, Chicago, has established a museum in which will be preserved and exhibited permanently objects of interest and value in the history of medicine. Especial attention will be given obsolete instruments and appliances for the diagnosis and treatment of disease. Many physicians and others have instruments that perhaps even a short time ago were in use, but which have been

laid away for more recent inventions; these are of historical value. Medicine in the United States has so brief a history that it should not be difficult to represent in this museum its complete development in the instruments and appliances that have come and gone, that have been of great value, but have given place to better inventions as the art has progressed. The late Professor Fenger bequeathed his own instruments to this museum, and it was the wish of this thoughtful man that his gift should be but the foundation for a collection that would show the development of the art he loved and for which he did so much. Rush Medical College has set aside a commodious room in the newly-opened Senn Hall for the permanent use of this museum. Gifts will be inscribed with the name of the donor and any remarks as to their history, original owner, user, etc., that may increase their interest. All other objects that have any interesting relation to the history of medicine or to renowned physicians will be given place, such as original manuscripts, autograph letters, portraits, etc. Information may be had by addressing Rush Medical College, Chicago.

The Berlin correspondent of the London *Times* states that the German government intends to have its customs officials instructed not only, as at present, in the superficial knowledge of the products of commerce and industry, but also in chemistry, physics and mechanical technology. It is also regarded as desirable that these officials should be acquainted with the elements of finance, of commercial policy and of commercial geography. At the most important customs offices in every province a laboratory, together with a library of technical books, will be established, where the minor officials will receive technical instruction from the customs officers of higher rank. These higher officials will themselves be trained in a great laboratory and auditorium which it is proposed to build at the chief customs office for foreign goods in Berlin. The teachers in this establishment will in part be professors of the technical colleges and kindred institutions in the German capital.

UNIVERSITY AND EDUCATIONAL NEWS.

The daily papers state that the Lawrence Scientific School of Harvard University will receive a very large sum from the estate of the late Gordon McKay, but there is, as yet, no official confirmation of this report.

By the will of the late Miss Mary T. Ropes, Harvard University will ultimately receive the endowment of a chair of political economy and a scholarship. Money for a chair of modern languages and a scholarship goes to the New Church University, a Swedenborgian institution at Albano, Ohio.

By the will of the late Dr. George Haven, the Harvard Medical School will ultimately receive $25,000 and half the residue of the estate.

Mr. J. B. Whittier, of Saginaw, has given $4,000 to the University of Michigan for a fellowship in botany.

It is announced that registration statistics for the year at Harvard show a total of 4,291 students in all departments, an increase of 65 over last year. The graduate school shows an increase of 83, while the college and scientific school show decreases of 37 and 19, respectively. The freshman class numbers 673, somewhat less than last year.

The freshman class at Yale University numbers this year 707, an increase, as compared with last year, of 69 in the Sheffield Scientific School and 39 in the Academic Department.

Five Rhodes scholars from South Africa began residence at Oxford at the beginning of the present term. They enter as ordinary undergraduate students, reading for the B.A. degree.

Dr. C. K. Edmunds, Ph.D. (Johns Hopkins), has been appointed professor of physics and electrical engineering at the Christian College in Macao, China.

At Trinity College, Cambridge, fellowships have been awarded to Mr. J. E. Wright, senior wrangler, mathematical tripos, 1900, and to Mr. H. A. Webb, bracketed third wrangler, 1902.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 6, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ADDRESS OF THE PRESIDENT OF THE SECTION OF EDUCATION OF THE BRITISH ASSOCIATION.

THE section over which I have the honor to preside deals with every branch of education. It is manifest that in an address your president can not deal with all of them, and it remained for me to choose one on which I might remark with advantage. As my official work during the last thirty-three years has been connected with education in science, I think I can not do better than take as my subject the action that the state has taken in encouraging this form of education, and to show that through such action there has been a development of scientific instruction amongst the artisan population and in secondary day schools. The development may not indeed have been to the extent hoped for, but it yet remains that solid progress has been made.

I have chosen the subject deliberately, as I find that there are very few of those who have the interests of education strongly at heart, or who freely criticize those who have borne the burden of the past, that have any knowledge of the trials and difficulties (some of its own creating, but others forced on it by public opinion) which the state, as represented by the now defunct Science and Art Department, had to contend with in its unceasing missionary

efforts in the cause of scientific instruction. I shall not attempt to do more than show that whatever its defect may have been in tact, whatever its shortcomings in method, that department still deserved well of the country for the work that it did in regard to the fostering of scientific instruction in the country at large.

As far back as 1852 the government of the day, influenced very largely by the Prince Consort, realized that it had an educational duty to perform to the industrial classes. Whether it was influenced by philanthropic motives or from the evidence before it that if Great Britain was to maintain its commercial and industrial supremacy scientific instruction was a necessity, it matters little. The fact remains that it determined that the industrial classes should have an opportunity of acquiring that particular kind of knowledge which would be of service to them as craftsmen. In this year 1852 the Speech from the Throne contained these words: "The advancement of fine arts and practical science will be readily recognized by you as worthy of a great and enlightened nation. I have directed that a comprehensive scheme shall be laid before you, having in view the promotion of those objects towards which I invite your aid and cooperation."

It is somewhat remarkable that the then ministry, of which Lord Derby was the chief and Mr. Disraeli the chancellor of the exchequer, did not survive to promulgate the scheme, which proposed theoretical rather than practical science, but that their successors, under Lord Aberdeen, issued it and commenced to carry it into effect. In 1853 the Department of Science and Art was established under the direction of Mr. Cole. Since 1835 so-called schools of design had been in being. These came under the new department, and it was determined to establish science classes for instruction in science, Dr. Lyon Playfair, the well-known chemist, being charged with the duty. Playfair resigned in 1858, and in 1859 Mr. Cole induced a young engineer officer, Lieut. Donnelly, to undertake the inspection and organization of science instruction throughout the country. It was through this officer's untiring energy and zeal that the classes in science flourished and were added to at this early stage of the new department's history. The same energy was displayed by Donnelly during the whole of his long career in the service of the state, and I feel that it was fortunate for myself to have served so many years as I did under one to whom the country at large owes a deep debt of gratitude.

Not long ago he passed away from us, and there will be no more lasting memorial to him than that which he himself erected during his lifetime in the fostering of that form of education which is of such vital importance to the national well-being.

To revert to history, I may record that the first science examinations conducted by the state took place in May, 1861, and, the system of grants being made on the results of examination having been authorized, the magnificent sum of 1,300*l*. was spent on this occasion on the instruction of 650 candidates, that number having been examined. Thus early was the system of examination commenced in the department's career, and the method of payments on the results of these examinations stereotyped for many years to come. There is reason to believe that the educational experts of that day considered that both were essential and of educational value, a value which has since been seriously discounted. Employers of labor in this country were not too quick in discerning the advantages that must ultimately ensue from this class of education if properly carried out and encouraged. Theoretically they gave en-

couragement, but practically very little, and this survives to some extent even to the present day. Some of the foremost employers, however, gave material encouragement to the formation of classes, insisting on their employees attending evening instruction; but conspicuous above all was Mr. Whitworth, who, in 1868, placed in the hands of the department the sum of 100,000*l.*, to be devoted to the creation of scholarships, which were to be awarded at the annual May examinations. The proviso made by him was that all competitors were to have had experience in practical work in an engineering establishment. Such candidates, it was evident, must have found out their own weakness in education, and, by working in science classes, could make up their deficiencies, and the award of these scholarships would enable them to study further. Sir J. Whitworth was farseeing and almost lived before his age, but the benefits that he has conferred, not only on individuals, but on science and industries, by his generosity will make his name to be remembered for generations to come. To have been a Whitworth scholar gives an *entrée* into various government and engineering posts, and we have in the front rank of science men who have held these scholarships and whose names stand prominent in the development of engineering.

Incidentally, I may say that no country but this, for very many years, considered that instruction in science for the artisan was a large factor in maintaining and developing industry. The educational interests of the employer and the foreman were, in some countries, well provided for, but the mechanic was merely a hand, and a 'hand' trained in merely practical work he was to remain. He could not aspire to rise beyond. We may congratulate ourselves that such a 'caste' system does not exist amongst ourselves.

For the first twenty-five years of the Department of Science and Art the grants given by parliament for science instruction were distributed almost entirely amongst those who were officially supposed to belong to the industrial classes, and no encouragement was offered to any higher class in the social scale.

It would take me too long to show that at first the industrial classes were very shy of seizing on the advantages offered them. Suffice it to say that they had to be bribed by the offer of prizes and certificates of success to attend instruction, and it was not for several years that the evening classes got acclimatized and became popular.

The evening instruction was then largely attended by adults. That this was the case may be judged by the fact that the average age of candidates who obtained successes in advanced chemistry was about twenty-five and in elementary chemistry about twenty-one. I have alluded to the apathy displayed by employers and by the artisans in the early days of the Department of Science and Art. The causes which dispelled it in both employers and employed, in regard to science instruction, will be found in the following extract from a report by the Department of Science and Art:—

The Paris Exhibition (1867) caused the work of this country to be brought into close comparison with that of the rest of the continent, and in many points both of manufacture and of skilled labor it was found that England did not stand in such a good position as she had done a few years back. Dr. Playfair, in a letter to the *Times*, drew attention to this, attributing much if not all the evil to the deficiency of our technical education among the artisan class. The substance of this letter was taken up by many persons of influence during the autumnal recess, and it led to a sort of educational panic, the cry for technical education becoming quite the absorbing topic among all circles and forming a considerable portion of the contents of all periodicals. Meetings were convened and addresses delivered all over the country, and the question was so much ventilated that im-

portant changes were anticipated in the educational arrangements of the country during the coming session of Parliament, which unfortunately were put off on account of the debates on the Reform Bill of 1868.

The agitation necessarily brought forward the work of the Science Division of the Science and Art Department, and it is not a little remarkable how completely the system which had been growing up since 1860 seemed to meet all the requirements of the case, and at the same time how few persons had any idea of its provisions in spite of all that had been done to spread a knowledge of the scheme.

There can be no doubt, however, but that this six years' work had silently, though materially, effected a change in the general tone of feeling on the subject of scientific education, and had been the means of preparing the country for the 1867 agitation. The different feeling among the working-classes on the subject is forcibly shown in the annual report of the Science and Art Department. From this it appears that in 1860 a pupil in one of the science classes in Manchester, a town usually looked upon as in advance of others, could hardly continue his attendance at the class owing to the taunts of, and ill-treatment by, his companions. Nevertheless, in the autumn of this year, 1867, hardly enough could be said or done to satisfy the desire for science classes being formed for those very persons who, but six years before, had considered attendance at a government science school as almost against the rules of their trade.

Such was the account of 1867 given by Mr. G. C. T. Bartley (now Sir G. Bartley, M.P.). The plan adopted by the Science and Art Department for encouraging instruction in science was perhaps the best that could be devised at the time, though we now know that it was capable of improvement. It may be mentioned that an improvement in it was made the next year by the introduction of a very large system of scholarships, scholarships which have enabled the possessors in some instances to continue their studies at universities, and several distinguished men owe their positions to this aid. It was in this same year that Mr. Whitworth established his scholarships, as before described.

I have endeavored to give a brief *résumé* of what was done during the first fifteen years of the existence of the Science and Art Department, and it continued to expand its operations after 1868 on the same lines for another ten years. In 1876 your president became connected with the department as a science inspector. I am sure the section will forgive me if I am somewhat personal for a few moments. During the previous eight years I had had the honor of being a teacher of some branches of physical science at the School of Military Engineering, and my own training was such that I had formed a very definite opinion as to how science instruction should be imparted, both to those who had a good general education and also to those who had not. The method was the same in both cases: it should be taught practically. I may say that though I had not myself had the advantage of being taught it at school, I had learned all the science I knew practically, and I entered the department fully impressed with this view. Whenever possible I have until the present time endeavored to impress this view on all who were interested in the work of the department. Much of the science that was taught in state-supported classes was largely book work and cram, and the theoretical instruction as a rule was unillustrated by experiment. This was undoubtedly due to the system of payments being based on success at the examinations. I must here say that there were honorable exceptions to this procedure. There were teachers, then as now, who knew the subjects they taught, and who were inspired by a genuine love of their calling. I can in my mind's eye recall many such, some of whom have joined the majority and others who are still at work and as successful now as then in rousing the enthusiasm of their students.

I am not one of those who think, as some

do, that cramming is entirely pernicious. A good deal of what used to be taught at public schools in my days was cram. It served its purpose at the time in sharpening the memory, and was a useful exercise, and it did not much matter if in after years much of it was forgotten. If the cramming is in science, a few facts called back to mind in after life are better than never having had the chance at all. In fact, as the faded beauty replied to the born plain friend, it is better to be one of the 'have beens' than a 'never wasn't.'

It was determined to make a vigorous onslaught against teaching that was unillustrated by experiment and to encourage practical teaching as far as could be done. Proper apparatus for illustrating lectures was insisted upon, and, with aid from the department, was eventually provided, though in some instances several years' pressure had to be exercised before it was obtained. I am bound to say that in many instances after it had been procured a surprise visit by the inspector during the hours of instruction often found that the lecture table was free from all encumbrance, and that the dust of weeks was upon the apparatus that should have been in use. This was sometimes due to the inability of the teacher to use the apparatus rather than to a wish to disregard the rules laid down by the department; but usually it was due to the fact that the teacher found cram paid best. I should like to say here that this state of things does not exist at the present time, and that the training of science teachers by the Royal College of Science and by other institutions has completely broken down the excuses that were often offered at that time.

The first grants for practical teaching were paid for chemistry. The practical work had to be carried out in properly fitted laboratories. There were not half-a-dozen at the time which really answered our purpose, and one of the earliest pieces of work on which I was engaged was in assisting to get out plans for laboratory fittings. These were very similar to those which I had designed for the School of Military Engineering several years before. Thanks to the Education Act of 1870 (I speak thankfully of the work that some of the important school boards have done in the past in taking an enlightened view of science instruction), there were some localities where the idea of fitting up laboratories was received with favor, and it was not long before several old ones were refitted, in which instruction to adults was given, and new ones established in board schools for the benefit of the sixth standard children. At that time an inspector's, like the policeman's, lot was not a happy one. We had to refuse to pass laboratories which did not fulfil conditions, though we left very few 'hard cases.'

Until after the passing of the Technical Instruction Act in 1887 the department aided schools in the purchase of the fittings of laboratories (both chemical and others), and year after year this help, which stimulated local effort, caused large numbers of new laboratories to be added to the recognized list. After six or seven years we had a hundred or more laboratories at work of what I may call 'sealed-pattern efficiency.' I am not very partial to sealed patterns, but they are useful at times, for they tell people what is the least that is expected from them. The pattern was not without its defects; but laboratories, like other matters, follow the law of evolution, and the more recently fitted ones show that the experience gained whilst teaching or being taught in a sealed-pattern type has led to marked improvements. Personally I am of opinion that only necessaries should be required, and I rebel against luxuries; for a student trained by means of the latter will, as a rule, in after life

fail to meet with anything beyond the mere essentials for carrying on his scientific work.

The sealed pattern is practically in abeyance, though it can be trotted out as a bogey, and any properly equipped laboratory is recognized so long as it meets the absolute necessities of instruction.

The half-dozen chemical laboratories which existed in 1877 have now expanded to 349 physical and 774 chemical laboratories. These are spread over all parts of England. I leave out Scotland and Ireland, as the science teaching is no longer under the English board of education.

It is only fair to say that many of this large number of laboratories are at present in secondary schools, regarding which I shall have to speak more at length. But the fact remains that in twenty-seven years there has been such a growth of practical science teaching that some 1120 laboratories have come into being. My predecessor in the chair likes to call laboratories 'workshops.' I have no objection, but the reverse; for the word 'laboratory,' like 'research,' sounds too magnificent for what is really meant, and all education should more or less be carried out in workshops.

The increase is as satisfactory as it is remarkable. It was only possible to increase the numbers in early days by gentle pressure and prophesying smooth things which, happily, did eventually come to pass. In latter days the increase has been almost automatic. The Technical Instruction Act has called into being technical instruction committees who in many cases have taken up science instruction in their districts in earnest. They, too, have had public money to allocate, and not a little has gone in the encouragement of practical education. It may, however, be remarked that had it not been for the preliminary work that had been done by the Science and Art Department it is more than probable that the Technical Instruction Act of 1887 would never have seen the light.

A reference must now be made to the removal of what any one will see was a great bar to the spread of sound instruction in every class of school where science was taught. So long as the student's success in examination was the test which regulated the amount of the grant paid by the state, so long was it impossible to insist on all-round practical instruction. It was impracticable to hold practical examinations for tens of thousands of students in some twenty different subjects of science. The practical examination in chemistry told its tale of difficulties. It was only when the Duke of Devonshire and Sir John Gorst in 1898 substituted for the old scheme of payments payment for attendance, and in a large measure substituted inspection for examination, that the department could still further press for practical instruction. For all elementary instruction the test of outside examination does more harm than good, and any examination in the work done by elementary students should be carried out by the teacher, and should be made on the absolute course that has been given. It seems to be useless or worse that an examination should cover more than this. Instruction in a set syllabus which for an outside examination has to be covered spoils the teaching and takes away the liberty of method which a good teacher should enjoy. The literary work involved in answering questions, for an outside examiner, is also against the elementary student's success, and can not be equal to that which may properly be expected from him a couple of years later.

Advanced instruction appears to be on a different footing. The student in advanced science must have gradually obtained a knowledge of the elementary portions of the subject, and it is not too much to ask

him beyond the inspection of his work to express himself in decent English and to submit to examination from the outside; but even here the payment for such instruction should be by an attendance grant tempered in some degree by the results of examination, since examiners are not always to be trusted.

The attendance grant was not viewed by some with great favor at first, and protests were received against its adoption, a favorite complaint being that it was sure to entail a loss of grant. One became suspicious that some of those who protested were aware that the last bulwark which defended the earning of grants by cram was being removed, and that inspection might prove more irksome than examination. This is past history now, and the new system works as smoothly as the old and with not more complaints than are to be always expected.

As I have said, grants were for very many years supposed to be confined to aiding the instruction of the industrial classes, but this limitation was more nominal than real. It might probably be imagined that it was no very difficult task to distinguish an artisan and his children from students who belonged to the middle classes. This was not the case, however. Children belonging to the industrial class were, on joining a science class, obliged to state the occupation of the father, and it was no uncommon thing for fathers to be given brevet-rank by their children. Thus, a brick-layer's son would describe his father as a 'builder,' which, if true, ought to have brought him into the ranks of the middle class. These unauthorized promotions were one of the difficulties the inspector had to face when judging as to the status of the parents. This difficulty was largely met by a rule that all those who attended evening classes were supposed to be of the industrial class; but as day classes increased the numbers of those who by no possibility could be of the artisan class also increased, and it became a very invidious duty of the inspector to put M.C. (Middle Class) against the names of many. It was determined by superior authority that only those students or their parents who could claim exemption from income-tax should be reckoned as coming within the category of industrial students. In early days the qualification for abatement on income-tax was a much lower figure than it is to-day, and almost each succeeding chancellor of the exchequer has raised the figure of the income on which the abatement could be claimed. To-day it is, I believe, 700*l*. a year, bringing the official definition as to membership of the industrial classes to an absurdity. It became evident to the official mind, which some people are good enough to say works but slowly, that the definition must be amended or the limitation abolished. The progress of events happily made the abolition the better plan, and was the means of allowing inroads of science instruction to be made into secondary day schools.

The history of these inroads I shall now give. Instruction given in so-called organized science schools was originally aided by the department by means of a small capitation grant. These schools were supposed to give an organized course of science instruction, and the successes at examination determined the payment. They were not satisfactory as at first constituted, and they so dwindled away in numbers that in 1890 only some one or two were left. A small increase in capitation grant in 1892 revived some of them, and a fair number existed in the following year. There was no doubt, however, that the conditions under which they existed were most unfavorable for a sound education, which ought not only to include science but also literary instruction. The latter was, in many schools,

wholly neglected, owing to the fact that the grants earned depended on the results of examination, and so all the school time was devoted to grant earning.

Mr. Acland, at this time minister for education, was made aware of this neglect to give a good general education, and as I was at that time responsible for science instruction I was directed to draw up a scheme for reorganizing these schools and forcing a general as well as scientific education to be carried out. Baldly the scheme abolished almost entirely* payments on results of examination, and the rate of grant depended on inspection and attendance. Further, a certain minimum number of hours had to be given to literary subjects, and another minimum to science instruction, a great deal of it being practical and having to be carried out in the 'workshop.' The payments for science instruction were to be withheld unless the inspector was satisfied that the literary part of the education was given satisfactorily.

The scheme was accepted and promulgated whilst the Royal Commission on Secondary Education was sitting, and, if I may be allowed to say so, Mr. Acland's tenure of office would be long remembered for this innovation alone, since in it he took a wide departure from the traditional methods of the department and created a class of secondary school which differed totally from those then existing. Needless to say the scheme was not received with favor on all sides, more especially by those who thought that serious damage would be done to secondary schools by the competition from this new development of secondary education. I am not ashamed to say that the disfavor shown on some sides made me rejoice, as it indicated that a move had been made in the right direction. At first it was principally the higher-grade board schools that came under the scheme, and in the first year there were twenty-four of them at work. This type of school gradually increased until about seventy of them, and chiefly of a most efficient character, were recognized in 1900. Their further increase was only arrested by the Cockerton judgment, now so well known that I need only name it. But here we come to a most interesting development. State aid, as already said, was at first limited to the instruction of the industrial classes, but no limitation as to the status of the pupil was made in this new scheme for the schools of science, and logically this freedom was extended in 1897 to all instruction aided by the department—the date when all limitation as to the status of the pupil was abolished, the only limitation being the status of the school itself. Thus, if a flourishing public school, charging high fees for tuition, were to apply to participate in the grant voted by parliament, it may be presumed, it would have to be refused. The abolition of the restriction as to the status of the pupils left it open to poorly endowed secondary grammar schools to come under the new scheme. To a good many the additional income to be derived from the grant meant continuing their existence as efficient, and for this reason, and often, I fear, for this reason alone, some claimed recognition as eligible.

* Within the next four years they will entirely cease.

Such is an outline history of the invasion of science instruction into certain secondary schools—an invasion which ought to be of great national service. In my view no general education is complete without a knowledge of those simple truths of science which speak to every one, but usually pass unheeded day by day. The expansion of the reasoning and observational powers of every child is as material to sound education as is the exercise of the memory or the acquisition of some smattering of a language. I am not going into the

question of curricula in schools, as I hope, regarding them, we shall have a full discussion. But of this I am sure, that no curriculum will be adequate which does not include practical instruction in the elementary truths of science. The president of the Royal Society, in his last annual address, alluded to the medieval education that was being given in a vast number of secondary schools. Those who planned the system of education of those times deserve infinite credit for including all that it was possible to include. Had there been a development of science in those days, one must believe that with the far-seeing wisdom they then displayed they would have included that which it is the desire of all modern educationists to include. Observational and experimental science would have assuredly found a place in the system.

One, however, can not help being struck by the broadening of views in regard to modern education that has taken place in the minds of many who were certainly not friendly to its development. Perhaps in the Bishop of Hereford, when headmaster of Clinton, we have the most remarkable early example of breadth of view, which he carried out in a practical manner, surrounding himself with many of the ablest teachers of science of the day. There are other headmasters who, though trained on the classical side, have had the prescience to follow in his footsteps, and of free will; but others there are who have neither the desire nor the intention, if not compelled to do so, to move in the direction which modern necessities indicate, is essential for national progress. I am inclined to think that the movement in favor of modernizing education has been very largely quickened by the establishment of schools of science in connection with endowed schools and the desire for their foundation by the technical instruction committees, who had the whisky money at their disposal, and who often more than supplemented the parliamentary grants which these schools were able to earn. It was the circumstance that the new scheme was issued when many endowed schools were in low water that made it as successful as it has been.

The number of schools of science increased so rapidly that it appeared there might be a danger of too many of this type being started on sufficient educational grounds. Science instruction was carried in them to such an advanced point and so many hours of the week were spent on it that they became in some degree specialized schools. At least eight hours a week had to be devoted to science, ten to literary instruction, and five to mathematics—any further time available could be spent on any section that was considered desirable. For some pupils the time devoted to science is barely enough, but for others who intend to follow careers in which the literary section should predominate it appeared that some curtailment of hours in the science section might be usefully allowed, and it became a question how far such instruction might be shortened without impairing its soundness. After much anxious thought it was considered that four hours per week, besides mathematics, was the very least time that ought to be devoted to such instruction, and that the latter part of it should be practical work. A scheme embodying this modification was approved by the lord president and the vice-president whilst I was principal assistant secretary for secondary education, and smaller grants than those for schools of science were authorized in 1901 for those schools which were prepared to adopt it. By the scheme instruction has to be given only in such subjects and to such an extent as is really necessary to form part of that general education of ordinary students who might not have to follow industrial pursuits. This modified and shortened course has met with

unqualified success. Some 127 schools came under the scheme the first year, and I gather that there will be a considerable increase in numbers in the future. The establishment of schools of science and of these schools may be considered to be a great step taken in getting practical instruction in natural knowledge introduced into secondary schools. The leaven has been placed in some 300 of them, and we may expect that all schools which may be eligible for state aid will gradually adopt one scheme or the other. Though it is said that there is nothing in a name, I am a little doubtful as to whether the earmarking of science education as distinct from secondary education is not somewhat of a mistake at the present day. For my own part, I should like to think that the days have passed when such an earmarking was necessary or advisable. The science to be taught in secondary schools should be part and parcel of the secondary education, and it would be just as proper to talk of Latin and Greek instruction apart from secondary education as it is to talk of science instruction. One of the causes of the unpopularity of the Science and Art Department was its too distinctive name. At the same time it would be most unwise at the present time, when the new education committees are learning their work and looking to the central authority for a lead, for the state to alter the conditions on which it makes its grants to these schools. It will require at least a generation to pass before modernized education will be free from assault. If science instruction is not safeguarded for some time to come it runs a good chance of disappearing or being neglected in a good many schools. As to the schools which have no financial difficulties, it is hard to say what lines they may follow. Tradition may be too strong in them to allow any material change in their course of study. If it be true that the modern side of many a public school is made a refuge for the 'incapables,' and is considered inferior to the classical side, as some say is the case, such a side is practically useless in representing modern education in its proper light. Again, one at least of the ancient universities has not shown much sympathy with modern ideas, and so long as she is content to receive her students ignorant of all else but what has been called medieval lore, so long will the schools which feed her have no great inclination to change their educational schemes.

If we would only make the universities set the fashion the public schools would be bound to follow. The universities say that it is for the public schools to say what they want, and *vice versa,* and so neither one nor the other changes. It appears to me that we must look to the modern universities to lead the movement in favor of that kind of education which is best fitted for the after life of the large majority of the people of this country. If for no other reason, we must for this one hail the creation of two more universities where the localities will be able to impress on the authorities their needs. The large majority of those whose views I share in this matter are not opposed to or distrust the good effects of those parts of education which date from ancient times. The great men who have come under their sway are living proofs that they can be effective now as they have been in times past, but we look to the production of greater men by the removal of the limitations which tradition sets. I myself gratefully acknowledge what the public school at which I had my early education did for me, but I think my gratitude would be more intense had I been given some small elementary instruction in that natural knowledge which has had to be picked up here and there in after life.

There is one type of college which I have not alluded to before, and that is the technical institutes. These have been fostered by the localities in which they are situated, and been largely supported by the whisky money, supplemented by government aid. I am glad to see that in the last regulations of the board of education these colleges will receive grants for higher scientific instruction, and I have no doubt that in the near future such institutions and schools of science will receive a block grant, which will give them even still greater freedom than they now enjoy. These are colleges to which students from secondary schools will gradually find their way, where they wish for higher education of a type different from that to be gained at a university.

I have endeavored to give a brief historical sketch of what the state has done in helping forward instruction in natural knowledge amongst the industrial classes, adults and children, and how gradually its financial aid has been extended to secondary schools. I have also endeavored to indicate the steps by which practical instruction has been fostered by it. I have done this because I am confident that ninety-nine educationists out of every hundred have but little idea what the state has been doing for the last fifty years. Some connected with secondary schools—I have personal knowledge—were until lately ignorant that the state had offered advantage to them of a financial nature. I may say that the work of the late Science and Art Department was largely a missionary work. It was abused, sometimes rightly but more often wrongly, for this very work, and it had more abusers at one time probably than any other government department. Even friends to the movement of modernizing education found fault with it as antiquated and slow, but I can assure you that no greater mistake can be made in pressing forward any movement than by any hurried change of front or by endeavoring to push forward matters too rapidly. In the first place, the treasury naturally views untried changes with suspicion, and this fact has to be dealt with more particularly when there is no great expression of public opinion to reckon with. At the same time it can not be stated too strongly that the treasury has in recent years dealt in a friendly and enlightened spirit with all matters which could affect the spread of science. Again, there is a hostility to great and rapid changes in the minds of those whom such changes affect.

The policy must always be to progress as much as is possible without rousing too great an opposition from any quarter, and I think it will be seen that the progress made during the last twenty-five years has, by the various annual increments, been perhaps more than could have been hoped for, and gives a promise for even more rapid advance in the future.

As an appendix to this address I have given a brief epitome of the increases in students, in schools, in laboratories, and in grants which have taken place since 1861. If to the last be added the amount spent out of the whisky money an additional half million may be reckoned.

It will be seen that the progress made has been gradual, but satisfactory, and that, if we showed some of the results graphically, weighed according to the circumstances of their date, and dared make an extrapolation curve of future results, we should have a complete justification for prophesying hopefully.

The question of the supply of science teachers has already been referred to. My remarks I should like to supplement by saying that in the greater number of schools teachers are to be found who have been trained at the Royal College of Science, and mostly at public expense—some

through scholarships gained by competition and some through training selected teachers. The success of the movement for the introduction of science instruction in schools depended on the proper supply of teachers, and even now the demand for men possessing the highest teaching qualifications in science is greater than the supply. It may be said, I think, that our science teachers from the college have one special qualification, and that is, that besides the knowledge of science, practical and theoretical, that they have acquired, they have lived in an atmosphere of what is called research, and which might be called original investigation. Professors, assistants and students alike are impregnated with it, and when the teacher so trained takes up his duties in his school he still retains the 'reek' of it. True instruction in science should, as I have before said, be practical, and practical instruction should certainly include original inquiry into matters old or new. The teacher who retains the 'reek' is the teacher who will prove most successful. It will thus be seen that the state had the task before it, not only of introducing instruction in science, but of training teachers to give such instruction. This problem is the same as now exists in Ireland, and the experience gained in England can not but be of the greatest use to those at the head of Irish technical education.

Before concluding there is one subject that I must lightly touch upon, and that is the supply of teachers other than science teachers. The Education Act of 1870 gave the power to elementary schools to train pupil teachers, who in the process of time would become teachers, either by entering into a training college by means of a King's Scholarship or, less satisfactorily, by examination. In large towns the need of a proper training for pupil teachers has been felt, and gradually pupil teacher centers were established, principally by school boards, where the training could be carried out more or less completely; but in the rural districts and smaller towns the pupil teacher has had to be more or less self-taught, and except in rare cases 'self-taught' means badly taught. The training college authorities make no secret of the fact that one of the two years during which the training of the teacher is carried out has to be devoted more or less to instructing the pupils in subjects they ought to have been taught before they entered the college. Thus all the essential and special instruction which is given has to be practically shortened, and the teacher leaves the college with less training than he should have.

The new Education Act has put it in the power of the educational authorities to rectify the defects in the training of pupil teachers. It is much to be hoped that councils will separately or in combination either form special centers for the training of all pupil teachers or else give scholarships (perhaps aided by the state) to them, to be held at some secondary school receiving the grant for science and recognized by the board of education as efficient. The latter plan is one which commends itself, as it ensures that the student shall associate with others who are not preparing for the same calling in life, and will prevent that narrowness of mind which is inevitable where years are spent in the one atmosphere of pedagogy. The non-residential training college, where the training of the teacher is carried on at some university college, is an attempt to give breadth of view to him, but if attempted in the earliest years of a teacher's career it will be even more successful. All teaching requires to be improved, and the first step to take in this direction is to educate the pupil teacher from his earliest day's appointment, for his influence in after years

will not only be felt in that elementary, but will also penetrate into secondary education. In regard to the additions which are required in elementary education, and which require the proper training of the pupil teacher, I must refer you to a report which will be presented to the section. The task of training pupil teachers is one which requires the earnest and undivided thought of the new education committees.

In the earnest address given by my predecessor in this chair he brought forward the shortcomings of secondary education and of the requirements for a military career in a trenchant manner and with an ability which I can not emulate. With much of what he said I agree heartily, but I can not forget that, after all, the details of education are to some extent matters of opinion, though the main features are not. We must be content to see advances made in the directions on which the majority of men and women educational experts are agreed. Great strides have already been made in educating the public both in methods and subjects, but a good deal more remains to be done.

It may be expected, for instance, that the registration of teachers will lead to increased efficiency in secondary schools, and that the would-be teacher, fresh from college, will not get his training by practising on the unfortunate children he may be told off to teach. It may also be expected that such increased efficiency will have to be vouched for by the thorough inspection which is now made under the board of education act, by the board, by a university, or by some such recognized body. It again may be expected that parents will gradually waken up to the meaning of the teacher's register and the value of inspection, and that those schools will flourish best which can show that they too appreciate the advantages of each.

I have to crave pardon for having failed to give an address which is in any way sensational. I have thought it better to review what has been done in the past within my own knowledge, and with this in my mind I can not but prophesy that the future is more than hopeful, now that the public is beginning to be educated in education. It will demand, and its wants will be supplied.

WILLIAM DE W. ABNEY.

APPENDIX.

Number of Schools of Science and their Grants.

Year.	Higher Grade Schools.	Endowed Secondary Schools.	Technical Institutes.	Total Schools.	Total Grants.
					£
1895	53	30	29	112	39,163
1898	69	50	49	168	98,849
1901	63	106	43	212	118,833
1903	50	119	57	226	Not yet known.

Number of Schools teaching Shortened Course of Science.

Year.	No.
1902	127
1903	184

Number of Laboratories Recognized.

Year.	Chemistry.	Metallurgy.	Physics.	Biology.	Mechanics.
1880	133	—	—	—	—
1900	669	37	219	17	4
1901	722	37	291	26	10
1902	758	39	320	34	14

Grants paid for Science Instruction.

Year.	Amount.	Year.	Amount.
	£		£
1860	709	1890	103,453
1870	20,118	1895	142,543
1875	42,474	1901	212,982
1880	40,229	1902	240,822
1885	63,364		

THE LONGITUDE OF HONOLULU, VARIOUS DETERMINATIONS, 1555–1903.*

THE occasion for this article is the recent determination by the telegraphic method of the difference of longitude of San Francisco and Honolulu through the new Pacific cable by Messrs. Edwin Smith and Fremont Morse, of the Coast and Geodetic Survey.

The first signals over this portion of

* Read before the Philosophical Society of Washington, October 10, 1903.

the cable were sent on January 1, 1903. The cable was opened for public use on January 5, 1903. The first observations in the telegraphic determinations of longitude were secured on April 20.

The cable company cooperated with the government by aiding the observers in various ways, and by granting the free use of the cable during a short period each night for their work.

Between April 20 and June 13 eleven determinations of the difference of longitude were made, five with the observers in one position and six after they had exchanged places for the purpose of eliminating the effects of their relative personal equation. The total range of the eleven results was only 0.17 s. No result differed from the mean by as much as one tenth of a second.

This degree of accuracy corresponds to that usually attained in determinations of the difference of longitude of two places connected by a telegraph line overland. Until within a few years such a degree of accuracy had not been possible for determinations made through long cables. The increase in accuracy has apparently been due to improvements made in the recording apparatus used by the cable companies.

The difference of longitude of the transit piers in San Francisco and Honolulu, respectively, was found to be, from the field computation, 2 h. 21 m. 38.92 s.

A revision of the computation still remains to be made, but the changes in this result will be very small. The chances are even for and against the difference stated, being within 0.03 s. of the truth.

The longitude of San Francisco from Greenwich is fixed by four transatlantic determinations by the telegraphic method, 1866, 1870, 1872 and 1892, and by a complicated telegraphic longitude net stretched across the United States.

The longitude of the Transit of Venus pier at Honolulu, as fixed by the new determination from San Francisco, is 10 h. 31 m. 27.24 s. west of Greenwich. Taking into account all the uncertainties in the chain of observations between Greenwich and Honolulu, the chances are even that the value stated is correct within 0.06 s., and it is almost certain that it is not in error by as much as 0.2 s. In the latitude of Honolulu 0.06 s. of longitude corresponds to 85 feet, or 1 s. to 1,418 feet.

The observers, Messrs. Smith and Morse, are still engaged in determining the differences of longitude over the three other spans of the cable between Honolulu and Manila. A good determination of the difference Manila–Guam has already been secured. When their work is complete the longitude of Manila will have been determined telegraphically in both directions around the world from Greenwich, and the longitude girdle of the earth will be complete.

The following résumé of various determinations of the longitude of Honolulu is condensed from an account furnished by Mr. W. D. Alexander, formerly Surveyor-General of the Hawaiian Islands, and now an assistant in the Coast and Geodetic Survey. It is especially interesting as showing the comparison of various determinations of a large difference of longitude by a variety of methods and extending over three and a half centuries.

In the following tabular statement the new determination of the longitude of the Transit of Venus station, 10 h. 31 m. 27.2 s., is taken as being correct in deriving the errors of the various determinations. In cases in which the older determinations referred to some other point than the Transit of Venus station, they have been reduced to that station by using the relations in position which are now known.

	Longitude of Transit of Venus Pier, Honolulu.	Error of Longitude.
	h. m. s.	
John Gaetano, 1555, no chronometers, no log	9 23	-68^{m}
Cook, 1785, observatory on Hawaii	10 31 45	$+18^{s}$
Vancouver, 1790, based on Cook, various points	45 to 27	+18 to 0
Freycinet, 1819	26	− 1
Wilkes, 1840, based on Cook	35	+ 8
Lyman, 1845–1846, moon culminations, predicted places	15	−12
Fleuriais, 1868, 27 moon culminations, first computation	21.8	− 5.4
Fleuriais, 1868, second computation	25.9	− 1.3
Tupman, 1874, 700 culminations, 13 occultations, 540 zenith distances of moon, first computation	15	−12
Tupman, 1874, second computation	27.2	0.0
Tupman, 1874, combined with first computation of Fleuriais	26.3	− 0.9
Tupman, 1874, combined with second computation of Fleuriais	26.7	− 0.5
Tupman, 1875, 20 chronometers, one trip, Honolulu to San Francisco	33.2	+ 6.0
Hawaiian Government Survey, 1884, chronometers, 2 round trips, Honolulu to San Francisco	25.8	− 1.4
Hawaiian Government, adopted in furnishing time	26	− 1.2
Hawaiian Government, adopted for mapping purposes	27.2	0.0

In the Spanish chart found by Lord Anson on board the galleon which he captured in 1743, a group of islands was laid down in the same latitude as the Hawaiian Islands, but 17° too far east.

The southernmost and largest island was named La Mesa, which seems to refer to Hawaii with its high tableland. North of it were La Desgraciada, probably Maui; and three small islands called Los Monjes, which may have been Kahoolawe, Lanai and Molokai.

This chart was published in the narrative of Lord Anson's voyage in 1749.

An official letter from the Spanish Hydrographical Department to the Hawaiian Government, dated Madrid, February 21, 1865, states that an ancient manuscript chart exists in the archives of that office, in which this group is laid down as in the chart of the Spanish galleon, with the name 'Islas de Mesa,' and a note declaring that they were discovered and named by Juan Gaetano in 1555.

The large error in the longitude of La Mesa, of 17°, more than 1,000 nautical miles, is not surprising when it is considered that chronometers were not yet dreamed of, that the Spanish navigators depended entirely on dead reckoning for their longitudes, that the use of the log for measuring the velocity of a ship was not known before 1607, and that the equatorial current would be effective in producing an error of the sign actually found. Thus La Pérouse, coming from California, found that the error in his dead reckoning caused by this current, when he arrived off Hawaii, amounted to 5° to the east, and Vancouver, coming from the south, found a similar error from the same cause, amounting to 5°14′.

When Captain Cook discovered Hawaii, in 1768, he was not aware that he had accidentally rediscovered La Mesa, and his successors at first retained both La Mesa and the Sandwich Islands on their charts, as may be seen in the atlas accompanying the early editions of Cook's 'Voyages.'

Seven years later, in 1785, two of Cook's officers, Portlock and Dixon, on their way to the northwest coast, as their crews were suffering from scurvy, headed their ships for the supposed position of La Mesa, sailed over it, and ran down the parallel of latitude till they arrived at Hawaii. A few days later La Pérouse, after searching in vain for La Mesa, did the same, and be-

came convinced of its identity with Hawaii.

The charts attached to the early editions of Cook's 'Voyages' placed Kealakekua Bay at 156°00′, or 18 s. too far west.

Although chronometers were put into use prior to 1714, as late as 1762 John Harrison won a reward of 20,000 pounds from the British government for having constructed a chronometer which, according to the test made, determined the difference of longitude of Portsmouth, England, and Jamaica within eighteen miles. The prize in question was offered in 1714, and it took 47 years to make sufficient improvements in chronometers to win it. Captain Cook's error of only 18 s., or four and one half miles in the longitude of Honolulu was, therefore, remarkably small for that time.

Captain Vancouver, in 1790, adopted the same longitude of Kealakekua as Captain Cook, viz., 156° 00′. The true longitude of Cook's observatory there is about 155° 55′ 30″. Vancouver gives for the longitude of his anchorage off Waikiki, Oahu, 157° 50′ 23″ w., which is only half a mile too far west, and for Wiamea, Kauai, 159° 40′ w., which is probably within a quarter of a mile of the true longitude.

Captain Freycinet, of the scientific exploring ship *L'Uranie,* in 1819, made the longitude of Kealakekua 156° 04′ 23″.5 w. from Greenwich, which is 36 s. too far west. He made the longitude of Honolulu 157° 51′ 46″.2 w. from Greenwich, which is about 1 s. too far east.

Commodore Chas. Wilkes, of the U. S. exploring expedition, in 1840, adopted Captain Cook's longitude of Kealakakua Bay, viz., 156° 00′ w., and placed Honolulu at 157° 54′ w., and Waimea, Kauai, at 159° 44′ 30″, both of them 8 s. too far west.

During the years 1845–6 the late Professor Chester S. Lyman, afterwards a professor at Yale University, who was then residing in Honolulu for his health, assisted Mr. David Flitner, chronometer maker, in establishing a small observatory here, and made a series of meridional observations of the moon, in order to determine the longitude. The result he obtained, using the *predicted* places of the moon in the American 'Ephemeris,' was 10 h. 37 m. 15 s. w., or 12 s. too far east.

In the year 1868, M. Fleuriais, in the service of the 'Bureau des Longitudes,' who came to observe a transit of Mercury at Honolulu, established an observatory near the Catholic Cathedral, where he observed nineteen meridional transits of the moon's first limb, and eight of the second limb. These observations are published in detail in the appendix of the *Connaissance des Temps* for 1872. The result, as first published, was 160° 10′ 38″ west of Paris, or 157° 50′ 23″.5 w. of Greenwich, or 5.4 s. too far east.

But in No. 2586–7 of the *Astronomische Nachrichten,* for April, 1884, we find a reduction of Fleuriais' observations for longitude, carried around the world in 1867–70. On pages 345–6 are given the single results obtained in Honolulu in October–December, 1868, 27 in number, and the longitude deduced from them is 10 h. 31 m. 25.59 s., or 1.3 s. too far east. These results were obtained by combining the observations at Honolulu with the actual observations of the moon's place made during the same period at Washington, Greenwich and Paris.

In September, 1874, Captain G. L. Tupman, Royal Marine Artillery, in charge of the British Transit of Venus Expedition of that year, arrived in Honolulu, and established an observatory on Punchbowl Street, near the shore, on practically the same meridian as C. S. Lyman's observatory, and 4″.79 west of Fleuriais' pier. No pains were spared to ascertain the longi-

tude by lunar observations, and the accuracy of the work has since been fully confirmed.

The observations for longitude were continued through the months of October, November and December, 1874. During this time over 700 meridional transits of the moon, thirteen occultations of stars, and about 540 zenith distances of the moon's upper and lower limbs, combined with those of well-known stars near the moon, were observed. The first reduction of the observations apparently agreed with the result obtained by Professor Lyman, viz., 10 h. 31 m. 15 s., but after returning to Europe and correcting the tabular right ascension by the contemporary observations made at Washington, Greenwich, Paris, Königsberg, Strasburg and the Cape of Good Hope, Captain Tupman increased the result by about twelve seconds of time. His final result by meridional transits of the moon was 10 h. 31 m. 26.0 s.; by zenith distances, 10 h. 31 m. 27.3 s.; by occultations of stars, 10 h. 31 m. 26.9 s.

The result officially communicated to the Hawaiian Government Survey was 10 h. 31 m. 27.2 s., upon which all the maps since then have been based. It is interesting to note that this value agrees to the tenth of a second with the latest determination of the longitude.

Captain Tupman, however, afterwards weighted the above results according to the number of observers employed on each, giving the occultation result the weight 5, the mean of the first two results the weight 4 and M. Fleuriais' result the weight 1, on which conditions the resulting longitude is 10 h. 31 m. 26.3 s. If he had used the value deduced from Fleuriais' work by the *Astronomische Nachrichten*, his final mean would have been 10 h. 31 m. 26.7 s.

In March, 1875, Captain Tupman made an attempt to connect Honolulu with San Francisco by transportation of chronometers. Accordingly twenty chronometers were carried by H. B. M. S. *Reindeer*, Commander C. V. Anson, from Honolulu to the U. S. Navy Yard, Mare Island, and compared with the local time at both stations. Unfortunately the *Reindeer* was blown out of her course by a northerly gale, which lengthened her voyage seven or eight days, and lowered the temperature in the chronometer boxes as much as 15° F. Hence the resulting determination of the longitude of Honolulu, viz., 10 h. 31 m. 33.2 s. ± 3.0 s. w., had very little value.

Again, in August and September, 1884, an attempt was made by the Hawaiian Government Survey with the cooperation of Professor Davidson and Mr. Morse in San Francisco, to determine the longitude of Honolulu by comparing the chronometers on board the O. S. S. Co. steamer *Mariposa*, with the local time at each end. This was done for two round trips, giving a mean result of 10 h. 31 m. 25.8 s.

In view of all the above facts, the Hawaiian government adopted 10 h. 31 m. 26.0 s. as the most probable value, in rating chronometers and furnishing standard time, but not for mapping, until the recent telegraphic determination made by the U. S. Coast and Geodetic Survey.

John F. Hayford.

SCIENTIFIC BOOKS.

A Discussion of Variable Stars in the Cluster ω Centauri. By Solon I. Bailey. Annals of the Astronomical Observatory of Harvard College, Vol. 38. 4°. Cambridge, Mass. 1902. Pp. 252; 13 plates.

Among the most interesting discoveries in the subject of variable stars during the last decade belongs the finding of an exceptionally large number of variables in certain globular star clusters. The remarkable fact that in many of these systems a not insignificant proportion of all the stars change their light

in a quite regular way, and that among the objects of one and the same system the elements of the light changes, especially the length of period, amplitude of variation and form of light-curve, show certain common characteristics, impels one to the acceptance of a common, or at least similar, cause for the changes of light. To be sure, up to the present time, no entirely satisfactory explanation has been found; but precisely this enigmatical character of the phenomenon, which, without doubt, stands in a certain relation to the stage of development of the cluster concerned, increases the interest in itself, and incites to further research on this new subject.

The credit for the discovery of the many variables in the star clusters belongs to Professor Bailey, who is in charge of the Arequipa Station of the Harvard Astronomical Observatory. This credit is much enhanced from the fact that the discoverer has taken upon himself the enormous task of studying the light changes of this increasing number of variables, and of determining their elements. The first fruit of this undertaking is the present volume, which is especially concerned with the cluster *ω Centauri*. The unwearied industry and great skill which the author, and his colaborer, Miss Leland, have shown in the measurement and study of the rich materials of observation, will call forth special acknowledgment and admiration, and one may well congratulate the Harvard Observatory on a publication which commands a prominent place among the valuable works of this institution.

This work bears eloquent witness also to the high importance which the application of photography has won in the development of astronomy at the present time. In general only by photographic means was the solution of the above problems possible. It is scarcely conceivable that in the densely crowded star clusters any such valuable results could have been obtained by direct estimates of brightness or measures in the telescope. Even the identification of the individual objects would present the greatest difficulties, and the precision of the observations would be injured by the troublesome nearness of the other stars, quite aside from the great expenditure of time which the execution of the work would require. On the other hand, a single photographic plate renders possible the determination of the brightness of all the variables in the cluster. By means of réseaux, by the use of enlargements, and the selection of special portions of the photographs, the discovery of the various variables is notably simplified. The danger of confusion can thus be wholly eliminated, and the first comparison of brightness can be checked by another determination, and improved at will by the independent estimates of another observer.

In the discussion of this comprehensive volume one naturally can not enter into all the details; and in what follows only the most important points in regard to the reduction of the observations and the most weighty conclusions are discussed somewhat carefully.

In the first chapter the author gives, first of all, a brief historical sketch in regard to the discovery of variables in the different clusters. The surprising phenomenon was first observed in the two clusters Messier 3 and Messier 5. In the first, Pickering, in the year 1889, had discovered a star near the center of the cluster, which he at first regarded as a nova, but which later proved to be an ordinary variable. In the second, Packer, in 1890, found by direct observations the variability of two stars, which was verified at the Harvard Observatory by means of photographic plates. Also in the same year Common made the discovery of several variable stars in this cluster. An examination by Mrs. Fleming and Professor Pickering of photographs made at Arequipa led in August, 1893, to the discovery of two variables in *ω Centauri*, and soon after followed the finding of six variables in 47 *Tucanæ* by Professor Bailey and Mrs. Fleming. In the year 1895, after Pickering and Bailey had succeeded in establishing the variability of 26 stars in *ω Centauri*, a systematic investigation of the densest star clusters was undertaken at the Arequipa Observatory, and this search brought to light a surprisingly large number of variables. A summary of all the objects discovered up to 1898 was given by Pickering in the

Harvard circular No. 33. The same is again published on page 2 of the present volume. In the 23 clusters which had been examined, 19,050 stars were compared, and not less than 509 variables were found. The distribution among the different clusters is very different. In two of them no variable was found, in three, only one; in four, only two; and so on. The two clusters Messier 3 and *ω Centauri* show the greatest number of variables. The first has 132 among 900 stars examined, the second, 128 among 3,000 stars compared; in the first case there is one variable in every seven stars, and in the second case one in every twenty-three.

In the present volume only the cluster *ω Centauri* is discussed, for which more material was available than for the others. In regard to number of stars it is the most striking cluster in the sky, and, on account of the brightness of the individual stars, photographs of it can be obtained with shorter exposures than of the other clusters.

To the naked eye it appears as a hazy star of the fourth magnitude. Its form is elliptical. A count of the number of stars, made in the year 1893, gave for the best photographs, 6,389. The diameter was taken as 35′, but a few variables were found somewhat more distant from the center, and as it appeared probable that these really belonged to the system, the borders of the clusters were thus somewhat extended, even to a diameter of 40′. In regard to the magnitudes of the stars, there is no star brighter than 8 magn., less than 100 stars between 8 magn. and 12 magn., and more than 6,000 between 12 magn. and 14½ magn. A large number of the stars which were counted may perhaps not belong to the system, but are only accidentally projected upon it.

The photographic plates which furnished the basis for the investigation were nearly all made with the thirteen-inch Boyden refractor, which for the photographic rays has a focal length of 191.5 inches. On the original plates, therefore, 1 mm. is equivalent to 42.4″. The images of the fainter stars have a mean diameter of 2″. This quantity, however, varies considerably on different plates. For keeping the position of the stars fixed on the plates no finder was used, but an eye-piece, which was inserted near the plate, in the field of the main telescope itself. A few plates were made with the Bruce 24-inch telescope, and with the 11-inch Draper telescope, which are of less focal length than the 13″. The time of the exposure which was necessary at Arequipa, in order to show the faintest variables when at minimum, was for *ω Centauri* 30 minutes. For the fainter clusters notably longer exposures are necessary: in the case of Messier 5 about 50 minutes, for Messier 3 about 100 minutes, and for others even two hours. In most clusters the central portions are so densely crowded with stars that a detailed study is quite impossible.

The method which was pursued by Bailey in the discovery of variables in clusters was substantially as follows: The particular cluster was divided into a number of parts each of which contained about ten stars. These stars were arranged in a so-called sequence according to their brightness, from the brightest to the faintest. This sequence was then memorized and as large a number as possible of original plates (if possible, at least ten) was tested and compared as to how and to what extent the particular sequence was changed. In this way the whole cluster was examined piece by piece. This labor is extremely tiresome. It demands a rigorous examination of numberless plates under a microscope of considerable power, in order to separate the thickly crowded portions, and extraordinary care not to confuse the different stars with one another. In all cases where the variation is small, or where the period is about twenty-four hours or a fraction thereof, the detection of the variability was difficult. On this account many variables may have remained undiscovered. Especially difficult is found the examination of the central portion, where the star images coalesce, and precise comparisons are impossible. On this account it happens that, especially in the densest clusters, relatively few variables are found near the center. The discovery is also rendered difficult from the fact that the duration of the maximum phase is only a com-

paratively short part of the whole period (sometimes only one fifth). For, since in the remaining time no noticeable changes occur, the variability is made apparent, in many cases, only by the examination of very many plates.

In order to determine the brightness of the variables in the cluster *ω Centauri*, in the first place, a system of 38 comparison stars was selected, whose brightness ranged between magnitude 9.0 and 14.6, and which lie either within the cluster itself or at least in its immediate neighborhood, in any case not farther from the center than the most distant variables. The mean difference in brightness between two successive sequence stars is about 0.15; for the brighter stars the interval is in general larger, while the fainter stars lie closer together. The method which was employed in the determination of the magnitudes of the comparison stars is that which Pickering has described in Volume 26, Part II. A comparison scale was first made in which by the use of a selected star a line of images was obtained on the same plate by clockwork, and also with exposures of different lengths. The star was first exposed for 810 seconds, then the telescope was moved by a slight amount in right ascension and the star again exposed, this time for 270 seconds. Four other images with exposures of 90, 30, 10, and 3 seconds serve to complete the scale. On the supposition that the photographic effect is proportional to the time of exposure, any two successive images of the six star impression on the plate would differ by about 1.2 magnitudes. That portion of the plate which contained the six images was cut out and, protected by a glass cover, was fastened in a small frame, and could be placed on any other plate. By the help of such a comparison scale the determination of the brightness of the 38 selected comparison stars was made by placing first the brightest of them between the two images of the scale, which seemed to stand next to it in intensity, by which means the difference of the interval was estimated to tenths. The same process was then performed for the second star, and in this way the difference in brightness between the two comparisons was determined in magnitudes. In just the same way the second comparison star was joined to the third, the third to the fourth, and so on, each one with the one following it in brightness. The whole work was not, moreover, carried out by the use of a single scale, but in all four different scales were used, and, moreover, each pair of stars was measured on several plates, for the most part on four. All the measures were independently made by Mrs. Fleming as well as by Miss Leland. In order to arrange all the brightnesses in magnitude, values were taken for the first three, which accorded with the photometric system of the Harvard Observatory, and the magnitudes of the remaining 35 stars were then obtained by the use of the differences found for the single pairs of stars, after the application of an unimportant correction, which was made on the assumption that the first three stars belonged to a different spectrum type from the others. The final magnitudes of the 38 comparison stars are given on page nine, in the last column of Table III.

It is obvious without extended discussion that the whole method of the determination of the brightness of the comparison stars does not permit the attainment of the highest degree of accuracy. Aside from the fact that the ratio between the times of exposure and the brightness of the images is not rigidly exact, as a result of which the different images do not differ from each other by precisely 1.2 magnitudes, the comparisons between two images of the scale is a somewhat uncertain operation. It is, therefore, not to be wondered at that the various columns of determinations show in part very strong systematic differences from one another, not only between the two observers, but also with the same observer on different plates, and especially with the use of different scales. Apparently the appearance of the star images played an important rôle. Also the different scales, on account of dissimilar atmospheric conditions, may give a noticeably different result. Perhaps it would have been better for the precision of the comparisons to have made the steps between successive images of

the scale less than 1.2 magnitudes, and yet more desirable would it have been for the formation of the scale to have made use, not of change in the time of exposure, but rather of the cutting down of the objective (which Pickering has already made use of on another occasion), not, however, through the use of circular caps, but by sectors, or to have made use of polarization methods for decreasing the light for the formation of the scale. It is thus only indicated by what method it may be possible to obtain greater accuracy. The Pickering method for the determination of photographic stellar magnitudes in and for itself in the present instance the reviewer regards as thoroughly commendable. It is without doubt preferable to various methods, especially to that of measuring the diameters of the stellar images.

In the second and third chapters are given the measurements of brightness of the variables in the cluster *ω Centauri*. The photographic plates employed for this purpose cover the time from May 15, 1892, to August 16, 1898. In all 128 variables were measured. At first 132 objects were selected as variable, and were designated with the numbers 1–132. But later the four stars Nos. 28, 31, 37 and 93, which appeared not sufficiently sure, were rejected. The extremely wearisome comparisons, which made the greatest demands on the endurance and skill of the observer, were made for the most part by Miss Leland. A smaller number of plates were measured by the author himself, especially for the purpose of determining the provisional periods. The measurements were made in such a manner that the variable was estimated between two comparison stars, one of which was brighter, the other fainter than the variable. The difference in brightness was estimated in grades. The method is thus the same as the well-known Argelander method of comparison by grades, which has proved so effective in direct observations of brightness in the sky. The value of a grade was not far from 0.1 magnitude. Generally only two comparisons were made. Only when the variable appeared equal to one of the comparison stars, two other comparisons were made, one with the fainter and the other with the brighter comparison star. All the observations for each of the 128 variables are given in tabular form on pages 17–124 of the volume. In all there are 15,000 determinations of brightness, and since on the average each determination consists of two comparisons, there are about 30,000 comparisons for bringing the results into form. In the tables are give the individual comparisons in grades, and also the derived magnitudes of the variables, as well as the residuals of the single estimattes from the mean, and also the phase, that is, the time between the mean time of the exposure and the preceding computed maximum, and finally the residuals of the observed magnitudes from the mean light curve found for the star in question. When this residual was 0.40 or more the measurement was repeated, and in case the new measurement brought no sure conclusion it was checked still a second or third time, eventually also by another observer.

Most interesting is the fourth chapter, which contains the results of all the observations. In the tabulated grouping of the elements of the light changes are found only 95 examples out of the 128 variables. For 13 variables no periods at all were found, and for 20 objects the results obtained were so doubtful that they are not given in the table itself, but are mentioned only in the remarks which follow the table. In regard to the method of determining the periods, the epochs, the extremes of brightness and the mean curves, no description at all is given in this chapter, and one only finds in the whole volume some brief notes on page 232. The method of computation is, however, so well known in such cases that a detailed description would perhaps be superfluous. The plates made on the successive days, May 3 and May 4, 1898, eight plates on the first, and six on the second date, which cover periods of seven and five hours, respectively, give for nearly all the variables a sufficient indication of the character of the light changes, and render possible in most cases the finding of an approximate value of the period. An improvement on this approximate period can generally be obtained

without great difficulty by the use of several groups of plates which in greater number were made on closely associated dates, as, for example, those of 1895, from May 31 to June 30, and of 1897, May 13 to June 17. So by degrees the period can be continually improved, until eventually a use of the widely separated observations is possible, with the use provisionally of a derived light curve, which then gives the final sure value of the period. When this value is once found, and an initial epoch determined, one can at length for each individual measure find the difference in time from the preceding maximum or minimum, arrange the magnitudes according to these differences, unite the several adjacent ones to means and by the help of these normal magnitudes construct graphically the mean light curve.

The light curves obtained by the author for the reasonably sure variables are reproduced in Plates II. to VII. at the end of the volume, and give a glimpse at the peculiarities of the light changes for the individual objects. The scale of these curves is chosen somewhat small. By a somewhat larger representation clearness would have been gained. The residuals of the individual observations from these curves have already been given in the table of observations in Chapter III. Also in Chapter IV., in a special table approximate values are found for the duration of the maximum and the minimum phases, as well as for the increase and the decrease of the light, and for the rate of increase and decrease in magnitudes per hour, and finally the mean residual, that is, the mean of the residuals from the curves without regard to sign. The last value varies between 0.07 and 0.25 magnitude, the mean being 0.128.

In order to obtain an idea as to the certainty with which the elements of the light changes may be derived from the available materials, the writer selected at random several stars, and without knowing beforehand the results obtained by the author, independently determined the elements. The results agreed closely in all cases with those in the present volume. One may, therefore, put full confidence in them. One who has himself carried out such computations and knows thereby how many attempts and approximations must be made before a satisfactory arrangement of all the materials of observation is reached, will at best be able to appreciate what enormous labor is involved in his table of elements.

A glance over this table shows that for nearly all the stars the length of period is only a fractional part of a day. Only 5 stars make an exception, which have periods of 1.35, 14.75, 29.34, 297 and 484 days, respectively. For 26 stars the periods are less than 10 hours; No. 19 has the shortest period, 7.2 hours.

The range of light variation is noticeably different for the different variables. The difference between the maximum and minimum brightness varies between 0.45 and 4.58 magnitudes, and in general also, as with variables not situated in clusters, the longer the period the greater is the amplitude. A range of less than 1 magnitude for the determined difference is found in the case of 56 stars. Where the amplitude is less than 0.6, or perhaps 0.5 magnitude, the determination of the light curve is naturally somewhat uncertain, and one must look upon these objects with some doubt. It ought not to be overlooked, however, that frequently the real changes in brightness will be somewhat greater than those given in the table, since for many stars the brightness changes with great rapidity at maximum, and on this account the photographs, especially when the exposure is very long, do not record the true maximum brightness, but one something less. Especially is the relatively long duration of the exposure, which for these swiftly changing objects may be a considerable part of the whole period, a provoking hindrance to the determination of the genuine light phenomena.

Of great interest is the study of the light curves. These are by no means alike for all the variables in the cluster. They are, however, always of certain types. The author has distinguished three different classes of light curves. The first class, in which 37 stars may be reckoned, is characterized by the fact that

the star remains at minimum during half of the period, perhaps with very slight fluctuations. Moreover, the light curve is uniform, the increase of light very rapid and the decrease noticeably slower. The amplitude of the light variations attains in general 1 magnitude and a little more, and the periods lie between 12 and 15 hours. The second class embraces the relatively small number of 19 stars. They differ from the first only in the fact that the long duration of minimum is absent, and that in general the increase is much slower. The decrease continues with ever-lessening rapidity till the beginning of the following increase. In many cases on the descending arm of the curve a 'stillstand' appears to exist. The whole range in brightness is generally less than 1 magnitude, and the periods range between fifteen and twenty hours. In the third class are counted about 34 stars. The peculiarities of these stars are that the durations of increase and decrease are not very different; also, the increase is in general somewhat shorter than the decrease, but in some cases they are equal, and it even happens that the opposite is true. The amplitude of the variation is for the most part not much greater than 0.5 magnitude, and the periods are between eight and ten hours.

As one sees, the three classes are not separated very widely from one another; especially, the second is only a little different from the first, and there are transitions from one to the other, but as a whole the differences of the changes in light, especially between the extreme members of the classes *a* and *c*, are marked. The circumstances by which the variations of light take place among the different members of the cluster, whether due to occultation, rotation or to other causes, must in any case be very different.

In regard to many peculiarities of the light curves of the different stars the remarks at the end of Chapter IV. give information. Notes are also found in regard to the doubtful objects for which no elements are given in the table.

The fifth chapter is devoted to a special study of four variables of the cluster. The author aimed to prove by this special investigation whether noticeably better results could be obtained if the number of comparisons of brightness was increased, and especially if comparison stars, greater in number, and in the immediate vicinity of the variable, were employed. For each of the selected variables a list of comparison stars was chosen, no one of which was more than 2′ distant from it. The variable was then compared with as many of these as possible, and the difference in brightness determined each time in grades. All the new measures were made independently by the author and by Miss Leland. The magnitudes of the new comparison stars were determined on four plates by joining them to the previously chosen fundamental stars, and also in this case by both observers independently.

In addition to these direct determinations, the brightness of the new comparison stars was also found by an indirect method, by which, as is done in visual comparisons of variable stars, by the comparison of the variables with the comparison stars the differences in brightness of these stars in grades were derived; and then by the union of the various differences a scale of grades was formed. The union of the values of the comparison stars, obtained in these two different ways, furnished at length definite values for them, from which the results of both observers were united to form mean values. The differences between the two observers are in general small, although there are indications of systematic differences. The magnitudes of the four variables were derived from the observations simply by the Argelander method, by the help of the scale of grades, first in grades and then in magnitudes.

The result of this somewhat complicated and prolix research was, in the case of three of the selected variables, a complete accordance with the previously derived elements, in which, naturally, as might be expected from the large number of the measures and especially from the greater nearness of the comparison stars, the residuals of the single observations from the light curve resulted somewhat smaller. The case was different with the fourth star, which of all the variables

in the cluster has the smallest range of brightness. For this variable, at first, a proof of 0.275 days had been derived, which, indeed, satisfied a large part of the observations. The new investigation gave a distinctly different value, 0.37987, and, moreover, made it probable that the period is not constant, but, within the time which the observations cover, varies between 0.3796 and 0.3801 day. At least with this assumption a noticeably better representation is obtained. Since in the case of this star the changes of brightness are not much greater than the unavoidable errors of measurement, it is not very surprising that the new determination, made with other comparison stars, has led to an entirely different result. The limit is here reached where the precision of the method employed in the determination of the brightness fails, and it appears more than doubtful whether the new result deserves more confidence than the old. It would, indeed, be wiser, where the light fluctuations are so small, not to attempt the determination of the period.

Under the heading, 'Miscellaneous Results,' in the last chapter is discussed a number of questions which are concerned with the precision of the measurements, the distribution of the variables in the cluster, the light curves, etc. Some of these investigations deserve to be taken up briefly.

The distance of the stars from the center of the cluster has a marked effect on the precision of the comparisons. The nearer the variables are to the center, and the more, on this account, the images run together on the photograph, so much more difficult also are the comparisons of brightness. Within a distance of 5′ from the center of the cluster are found 46 variables; for 16 of these, on account of the difficulty of the observations, no period at all could be found, and for the remaining 30 the mean deviation from the corresponding curves is for the whole ±0.159 magnitude. On the other hand, for 35 variables whose distance from the center lies between 5′ and 10′, the corresponding mean deviation is only ±0.114 magnitude, and for 30 stars, whose distance is greater than 10′, it is only ± 0.113 magnitude.

When the deviations of the individual observations from the mean light curve attained a value of 0.40 magnitude and greater, the observations were repeated. In certain cases it happened that errors of measurement existed, which were due to errors of identification, probably. Very many large residuals are found, however, in all 287 cases, which are verified by the measurements of the revision. These residuals have their cause, perhaps, in real irregularities of the light curve, perhaps also in defects on the photographic plates. The general quality of the plates has naturally an influence on the precision of the results, and in general the sharpest and best plates give the smallest residuals; while with very experienced observers and with the extremest care the gain is not so important as one might expect beforehand.

Since it is known that in case of comparisons of brightness of two stars in the sky their relative position plays an important rôle, it was of importance to investigate whether in the determinations on photographs the relative position of the two star images might exercise a marked effect. To find the answer to this question one of the variables was compared on several plates with a number of comparison stars, while, by turning the plate under the microscope, the comparison star was placed first on the right and then on the left of the variable, and each time the difference in brightness was estimated in grades. It was thus shown that the influence of the change in position, if it exists at all, is so small that it can be completely ignored.

Of special interest is the investigation concerning the distribution of the variables in the cluster. The author has for this purpose divided the variables into twelve groups, of which the first includes all to a distance of 2′ from the center, the second those whose distance lies between 2′ and 4′, etc. For each group the number of variables per square minute was computed. The following table contains the results for the different groups. Next to them are given the corresponding numbers for the distribution of all the stars of the cluster, which were taken from a previous publication in the *Harvard Annals*. The

numbers in the last column, which give how many variables are found in the different groups for each 100 stars, are not noticeably different from one another. It follows, therefore, that in the whole cluster, in a definite area the proportion of variables is about constant, and that in no place occurs a very large number.

Variables.			All Stars.		
Mean Distance of Group.	Number.	Number per Square Minute.	Mean Distance of Group.	Number per Square Minute.	Per Cent.
1′	7	0.556	1.1′	42.8	1.3
3	26	0.690	3.1	32.3	2.1
5	21	0.334	5.2	19.7	1.7
7	17	0.193	7.1	12.3	1.6
9	17	0.150	9.1	6.5	2.3
11	16	0.116	11.1	3.9	3.0
13	9	0.055	13.3	2.8	2.0
15	6	0.032	15.0	2.1	1.5
17	4	0.019	16.7	1.6	1.2
19	4	0.017	18.4	1.1	1.5
21	0	0.000	20.2	0.7	—
23	1	0.003	—	—	—

In regard to the three classes into which the variables were divided, the mean distances of the stars from the center of the cluster of the different groups are 7.7′, 8.1′ and 8.9′. It appears, therefore, that no marked difference is indicated in the distribution, on account of the character of the light changes. The mean maximum brightnesses of the three classes are 12.99, 13.10 and 13.33 magnitudes, and the minimum, 14.11, 13.97 and 13.89 magnitudes. The amplitudes are thus distinctly different. The mean lengths of the periods are 0.58617, 0.75153 and 0.39463.

It is of great value that for the 95 variables whose periods are determined the light curves are given not only graphically in Plates II. to VII., but that the coordinates of the light-curves are given in detail on pages 210 to 222, and in such a way that for each star the period is divided into 24 equal parts, and for each part the corresponding brightness is given. There are also given typical light tables for the three classes, by taking from each class five especially characteristic examples, and taking the mean values for these.

The chapter closes with some remarks concerning the possible causes of the light changes of so many stars in one and the same cluster. The author hesitates to accept widely current hypotheses, and to test them from the available materials of observation. He concludes only that from the complete uniformity of the periods, which is shown in *ω Centauri* for a long time, the variability must be associated with some regularly returning phenomenon, either through regular eclipses by bodies which are in revolution about each other in definite paths, or through the rotation of unequally illuminated or irregularly shaped bodies. The explanation by means of occultations, as with Algol stars, involves great difficulties. For, if one would assume, as at first sight might appear plausible, that the planes of the orbits of the different double star systems of the cluster lie about parallel to each other, and that on that account the light-curves of the different systems should show a certain similarity, the form of the light-curves, nevertheless, speaks against the eclipse theory. In *ω Centauri* are found three different types of light-curves, but in other clusters investigated by the author the first type with the long duration of minimum is so much more common that we may regard this as the characteristic type of variables in star clusters. This type of light-curve is, however, entirely distinct from the Algol type. The eclipse would have to last for a considerable part of the period, and this would hardly be consistent with any orbit system. Also the assumption of an axial rotation with unequally luminous surfaces seems not very probable, when one considers that such a large number of similar variables is concerned. The whole phenomenon is at this time somewhat enigmatical, and we must await the investigation of the occurrences in other clusters before further conclusions are permissible.

In an appendix to the volume are given preparatory studies toward the measurements of all those clusters in which more than one variable has been found. There are given the positions of those objects selected to serve as fundamental stars, and the comparison stars

chosen for the comparisons of brightness, and the stars already known to be variable, all the positions being given in seconds of arc, and determined from the center of the particular cluster. In Plates VIII. to XII. are given reproductions from the original plates of fourteen clusters, on which the variables and comparison stars are marked. On these reproductions 1 mm. equals about 10″. Especially interesting are the repeated enlargements of certain portions of some clusters, which are given in the last plate of the volume. These show clearly the change in appearance of the variables on different plates, and give an idea of the certainty with which the comparison with adjacent stars can be made.

From the materials given in the appendix one sees that there still remains a very great amount of labor to be done. We hope that the author will be able to carry out his plan, and to give as clear and exhaustive a discussion of the light changes in the other star clusters, as he has done in the present volume.*

G. Müller.

SCIENTIFIC JOURNALS AND ARTICLES.

The contents of the *American Journal of Science* for November are as follows: 'Mineralogical Notes,' by C. H. Warren; 'Studies of Eocene Mammalia in the Marsh Collection, Peabody Museum' (with plates XVI. and XVII.), by J. L. Wortman; '*Tridenum Virginicum* (L.) Rafin,' a morphological and anatomical study (with figures in the text), by T. Holm; 'Ephemeral Lakes in Arid Regions,' by C. R. Keyes; 'Note on the Identity of Palacheite and Botryogen,' by A. S. Eakle; 'Colloidal Gold: Absorption Phenomena and Allotropy,' by J. C. Blake.

SOCIETIES AND ACADEMIES.

AMERICAN CHEMICAL SOCIETY. NEW YORK SECTION.

The first meeting of the season was held at the Chemists' Club, No. 108 West 55th Street, on Friday evening, October 9.

After a few remarks by the chairman, Professor Miller, outlining the policy of the section for the ensuing year, and requesting members to present papers in abstract as far as possible, so as to have more time for discussion, the following papers were read:

The Volumetric Determination of Zinc: W. J. Waring.

This paper was read by Mr. Stone and discussed by Messrs. Brenneman, Stone, Miller and Danziger. It called attention to the widely differing results which are obtained by different chemists in the determination of zinc by the ferrocyanide titration method, and pointed out the necessity of uniformity in the conditions of standardizing and titrating, so that the composition of the precipitate shall be uniform. The occurrence of cadmium in the ores of the Joplin District in amounts varying from 0.1 to 2 per cent. was shown to interfere with the accuracy of the method, so that the cadmium should be removed, best by aluminum foil, before the titration. A new cadmium ammonium ferrocyanide was also described.

The Reduction of Lead from Litharge in Preliminary Assays and the Advantages of an Oxide Slag: E. H. Miller, E. J. Hall and M. J. Falk.

Professor Miller gave an abstract of an article which will soon appear in the *Transactions* of the American Institute of Mining Engineers. It was shown in making preliminary assays to determine the reducing power of an ore that, not only did the amount of lead reduced vary with the acid or basic character of the slag, but that the amount of lead oxidized by niter varied with the reducing agent present, even under uniform conditions as to charge, time and temperature. This was not anticipated, and explains the difficulty in the old preliminary assays.

The best results were obtained by using a charge of ore 3 grams, litharge 50 grams, soda 10 grams, no silica, no borax glass and no salt cover. With this charge and a temperature of over 900° C. the sulphur is completely oxidized to sulphate and forms an upper layer in the slag (Na_2CO_3 and Na_2SO_4), while the lower layer consists of a readily fusible mixture of oxide of lead, of iron, etc.

* Translated from *Vierteljahrsschrift der Astron. Gesellschaft,* 38. Jahrgang, Erstes Heft, 1903.

This style of charge was then tested with a quantity of ores containing sulphur combined with iron, copper, zinc and lead. The charge for the final assay was ore 1/2 assay ton, litharge 70 grams, soda 15 grams. Niter as calculated for a 20-gram button (from the results of the preliminary assay). The buttons were soft, malleable and weighed from 17–23 grams, while the results in gold and silver were slightly higher than the old methods and the loss in the slag slightly less.

The Influence of Diet, Muscular Exertion and Loss of Sleep upon the Formation of Uric Acid: H. C. SHERMAN.

Observations made in connection with metabolism experiments upon three professional athletes and one subject of sedentary habits showed the quantity of uric acid eliminated to be primarily dependent upon the quantity of meat products in the diet, and to be influenced very little, if any, by the abundance of a bread and milk diet, by a considerable loss of sleep, or (in the case of the professional athletes) by long-continued muscular exertion. With the subject of sedentary habits, a much smaller amount of exercise increased slightly the uric acid elimination. This paper will appear in the November issue of the *Journal of the American Chemical Society.*

H. C. SHERMAN,
Secretary.

ELISHA MITCHELL SCIENTIFIC SOCIETY.

AT the 150th meeting of the Elisha Mitchell Scientific Society, held in the Chemical Lecture Room of Person Hall, University of North Carolina, October 13, the following papers were presented:

The Use of the Vector Diagram in Electrical Engineering: Mr. J. E. LATTA.

Tanning (with specimens): Professor CHARLES BASKERVILLE.

After outlining modern methods of tanning, especially by the use of chromium nitrite, a number of rare skins which had been done for Messrs. Tiffany & Co., of New York, were exhibited. The skins were presented to the Museum of the Chemical Laboratory.

The Influence of the Spermatozoon on the Larval Development of the Sea-Urchin: Professor H. V. WILSON.

A New Indicator: Professors E. V. HOWELL and A. S. WHEELER.

A new indicator extracted from the hulls of the muscadine or wild Bullace grape was announced. This coloring matter gives a red color with acids and green with alkalies, being purple in neutral solutions. The only solvents so far found which may be used for its extraction are alcohol and water. It responds to inorganic and organic acids and volatile and non-volatile alkalies. Carbon dioxide does not affect it.

On adjournment of the public session, the annual meeting was held for the election of officers and transaction of business. The proposed agreement with the North Carolina Academy of Science was approved. By this agreement the *Journal of the Mitchell Society* becomes the official organ of the North Carolina Academy of Science, its size being doubled and issued quarterly. The following officers were elected for the ensuing year:

President—Professor Charles Baskerville.
Vice-President—Mr. J. E. Latta.
Recording Secretary—Professor A. S. Wheeler.

President Venable retains the permanent secretaryship.

CHARLES BASKERVILLE,
Secretary.

DISCUSSION AND CORRESPONDENCE.

A HITHERTO UNDESCRIBED VISUAL PHENOMENON.

TO THE EDITOR OF SCIENCE: The phenomenon of apparent movement described by Dr. Gould (SCIENCE, XVIII., 536) was discussed in 1896 by Professor S. Exner in an article entitled 'Ueber autokinetische Empfindungen' (*Zeits. f. Psych. u. Physiol. d. Sinnesorgane,* XII., 313). According to Exner, the first observation on record was made by Alexander von Humboldt in 1799. Several authors (among them men as well known as Aubert and Charpentier) have occupied themselves with the phenomenon; and it forms the subject of an experiment in Sanford's *Laboratory Course,* 1898, 309.

E. B. TITCHENER.

SHORTER ARTICLES.

PHOTOTROPISM UNDER LIGHT-RAYS OF DIFFERENT WAVE-LENGTHS.

The effect of lateral incidence of light upon *Cormophytes* is of such a nature as to produce a tendency in the plant to arrange its axis parallel to the direction of the incident ray. This response to the stimulus of light is quite general with regard to higher plants, and has long been known under the name *heliotropism.* The term *phototropism*—from its literal meaning more appropriate—has recently been introduced to displace the older term.

The relative phototropic effects of rays of different wave-length have been given by Wiesner* to be greatest between ultra-violet and violet rays, diminishing gradually over to the yellow, where it disappears, then beginning in the orange and reaching a small secondary maximum in the ultra-red. Guilleman's† results resembled those of Wiesner excepting with respect to the yellow. He concluded that curvature takes place under all the rays except the least refrangible heat rays. Sachs himself states that under blue light curvature takes place as in ordinary daylight, and that no curvature whatever takes place behind a ruby-red glass; and he agrees with Wiesner that no curvature takes place behind a yellow screen.

With regard to the decoloring effect upon a fresh alcoholic solution of chlorophyll by rays of different wave-length, the present position is practically that expressed by Vines:‡ 'Sachs and Wiesner have ascertained that the rays of low refrangibility are more active in forwarding it than those of high refrangibility.'

Some investigation of these subjects has been made by the writer, and the results are here given because they differ materially from those referred to, and because it is thought the methods here used to test the matter are less open to objection and more complete than those of the authors mentioned above.

The following named glass plates (each nine by twelve inches) were secured from Bausch and Lomb and are what are commonly called standard 'colors'—*violet, blue, green, yellow, red*—several of each. Window-glass was used to admit daylight, and sheet iron for the opaque screen. These colored plates were examined by the writer with a view to getting the particular spectrum of each, because colored glass can scarcely be represented accurately by simply *naming* the 'color'; for certain colored screens allow other 'colors' to pass than that which would seem from ordinary observation. The curve for each 'color' is plotted approximately in the accompanying

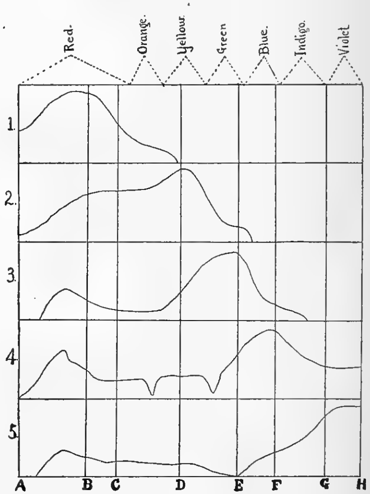

Fig. 1.

figure—1, red; 2, yellow; 3, green; 4, blue; 5, violet. The letters A, B, C, D, E, F, G, H are the ordinary significant points (Fraunhofer lines) of the solar spectrum. It will be seen that there is none of them, with the exception possibly of the red, which can be considered entirely a pure 'color.' However, they are fairly close approximations towards simple 'colors,' and as such are of some significance in regard to the subject under discussion.

In order to test the relative *phototropic*

* 'Die Heliotrop. Erschein. im Pflanzenreich.'

† *Ann. de Sci. Nat.*, IV.; 7; 1858. Both referred to by Sachs, 'Plant Physiol.,' p. 696.

‡ 'Lectures on Plant Physiol.,' p. 266.

effects of the screens mentioned, a number of metal frames were made so as to admit of free insertion of any of the plates into any of the four vertical sides of the frame. The plant to be used in the test was placed within the frame and enclosed on two opposite sides by opaque screens, and on the other two vertical sides were placed plates of two different 'colors.' On the top and the bottom were opaque plates. Then the plant was enclosed within the 'lantern' and placed equally distant from the two color-screens. No light was admitted to the plant excepting that coming through the two screens; and, since the top was covered, the plant was subjected to lateral illumination from two different 'colors' at the same time and from opposite directions. Care was taken to have only diffused daylight enter the screens and to have it equal in intensity. Now it seemed reasonable to conclude that if curvature of the stem of the plant took place toward *one* of the colored screens, the light which penetrated *that* screen produced most phototropic stimulus. The lanterns, not being actually air-tight, permitted the plant to live under more natural conditions of temperature, moisture and air than could be obtained by means of a double bell-jar.

The results obtained are summarized as follows and are represented by the curve given in Fig. 2, *I*. They rank in order named: *blue, white* (window glass), *violet, green, yellow, red, dark* (opaque). Between certain pairs of these screens the difference is not very great, but there is a positive difference in every case.

The main differences between these results and those of Wiesner, Guilleman and Sachs are in regard to the blue, the yellow and the red. Sachs states, p. 696, that curvature takes place behind a blue solution of ammoniacal oxide of copper as in full daylight. This is scarcely exact, because curvature is more prominent behind the blue screen than behind diffused daylight. It is also shown clearly here that curvature *does* take place behind red and behind yellow, though they produce less of a phototropic stimulus than any of the others, the yellow being stronger than the red. Wiesner states that no curvature takes place behind yellow, though he assigns some phototropic effect to red. An extra series was arranged to test the point as to whether no curvature takes place behind yellow or red. Lateral illumination was given through each of these two screens in different lanterns, and it was found that both produced distinct curvature. The lanterns were arranged so as to admit diffused skylight and also, at other times, weak diffused light from the room through the screens. In every case there was the same result.

Another series of experiments was performed with these colored screens to determine the decoloring effect of such light upon chlorophyll in solution. The solutions were

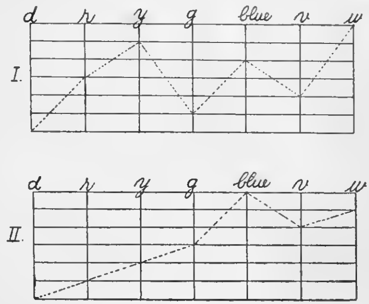

FIG. 2.

fresh alcoholic solutions and in each test the solutions were of exactly the same concentration, but solutions of different degrees of concentration were used to see if strength of solution had anything to do with the results. The conclusions reached were as summarized in Fig. 2, *I*, and in the following order commencing with the quality of light having the greatest decoloring effect: 1, *Diffused light* (in no case was direct sunlight used in the test); 2, *yellow;* 3, *blue;* 4, *red;* 5, *violet;* 6, *green;* 7, *darkness*. The result of this experiment showed that there was but small relationship between the phototropic effects and the decoloring effects upon chlorophyll in so[illegible]n. It is quite clear that there is little in co[illegible]mon (see Fig. 2, *I* and *II*). Sachs and Wiesner both say that the rays of low re-

frangibility produce greater decoloring effect than those of high refrangibility, but from the results obtained here it would seem that decoloration is in no way directly or inversely proportioned to refrangibility. It will be seen that the blue and the red are close together here, while in the solar spectrum they are far apart.

In the accompanying Fig. 2, *I* is given the curve of decoloration of an alcoholic solution of chlorophyll with the screens already described. The vertical lines represent *relative* quantity of effect—*d*, darkness; *r*, red; *y*, yellow; *g*, green; *v*, violet; *w*, weak diffused light. In Fig. 2, *II* is given the curve for relative phototropism. In both cases no attempt is made to represent the actual difference between any two as compared with any other two, *e. g.*, in Fig. 2, *II*, *blue* is three units above *green* simply because it happens to be stronger (in effect) than *diffused light*, which is stronger than *violet*, which is stronger than *green;* nor is it intended that the 'colors' indicated shall be in the exact position of the spectrum, though so far as the 'colors' are concerned they are in that order.

In nearly all the experiments the apparatus was indoors, and the light exposure chiefly north. Some light came from the east and about an equal amount of exposure toward the west. The first experiments were made in the greenhouse, but it was found that too much heat was produced, resulting in the wilting and even in the death of the plants. However, so far as carried on, the results were identical with those under diffused light.

The plants which proved most susceptible to phototropic influences were barley, wheat and tobacco seedlings. The best, most positive and the quickest results were obtained with wheat and with barley seedlings from five to forty mm. high. Other seedlings used were *Catalpa*, *Datura*, bean, pea, corn, sunflower and pumpkin.

No attempt is here made to deduce a physiological or a physical law from these phenomena because it is thought that sufficient data are not yet at hand; nor is there any quantitative effect estimated as exist between any two of the screens used. It is quite clear, however, that the statements of Sachs and others, namely, that the effect, whether phototropic or bleaching of chlorophyll solution, varies as the refrangibility, is not correct. It may be, however, that had the formulæ of their screens been given, it might be possible to see how they arrived at their results.

On looking at the spectra of the screens here given it may be seen that the blue permits considerable of other 'colors' to pass through, especially red. Now, since the phototropic effect of blue is greater than that of diffused daylight, the conclusion naturally follows that some portion of the solar spectrum is negatively phototropic because the blue as well as the other 'colors' passes through window glass. The question at once is suggested then as to where in the spectrum this negative portion is; but seeing that all the 'colors' here given are positively phototropic, the one conclusion is left, and that is but a mere suggestion, namely, that it may occur in those darker bands in the blue represented by the sharp down curve in its spectrum.

It is the intention of the writer to investigate this point by securing screens as nearly as possible corresponding to those portions of the spectrum; and at the same time to examine other intervening 'colors.'

J. B. Dandeno.

Agricultural College, Mich.

SCIENTIFIC NOTES AND NEWS.

At the last meeting of the Rumford Committee of the American Academy of Arts and Sciences, the sum of three hundred dollars was granted to Professor W. J. Humphreys, of the University of Virginia, in aid of his research on the shift of spectrum lines due to pressure; and the sum of two hundred and fifty dollars to Professor N. A. Kent, of Wabash College, in aid of his research on the circuit conditions influencing electric spark lines.

Dr. Carlos J. Findlay, of Havana, well known for his work on yellow fever, has been elected president of the American Public Health Association. The next meeting of the association will be held in Havana in April.

THE council of the Royal Meteorological Society has awarded the Symons gold medal to Hofrath Dr. Julius Hann, of Vienna, in recognition of the valuable work which he has done in connection with meteorological science. The medal, which is awarded biennially, was founded in memory of Mr. G. J. Symons, F.R.S., the originator of the British Rainfall Organization. It will be presented to Dr. Hann at the annual meeting of the society on January 20.

PROFESSOR FLINDERS PETRIE, F.R.S., has been appointed a delegate from the University of London to the International Congress of Archeology to be held at Athens in April, 1905.

The Botanical Gazette states that Dr. O. Melville Ball, of Batesville, Va., has been elected a member of the German Botanical Society.

DR. H. N. STOKES, of the U. S. Geological Survey, has been appointed chemist in the National Bureau of Standards. His temporary and mail address is Bureau of Chemistry, Department of Agriculture, Washington, D. C.

MR. W. J. PALMER, a graduate of the Ontario Agricultural College, has been appointed director of agriculture in the Orange River Colony at a salary of $6,000 per annum.

PRESIDENT H. S. PRITCHETT, of the Massachusetts Institute of Technology, has, according to the daily papers, tested the high speed electrical railway at Zossen, and has examined the Hamburg closed harbor. He will sail from Cherbourg for New York on November 11.

DR. ALBERT D. MEAD, professor of comparative anatomy in Brown University, has returned from a three months' trip through England, Holland, Germany, Italy and France, during which a thorough inspection was made of all the important biological laboratories and experiment stations.

MR. W. T. SWINGLE has returned to Washington after a study of the plants in the regions about the Mediterranean.

PROFESSOR FILIBERT ROTH, who holds the chair of forestry in the University of Michigan, has been elected forest warden of the state.

The American Geologist notes appointments as follows: Professor E. C. Perisho, of the State Normal School of Platteville, Wis., has been appointed state geologist of South Dakota and professor of geology in the State University. Dr. A. G. Leonard, assistant state geologist of Iowa, has been appointed professor of geology in the University of North Dakota, and Dr. A. F. Wilder, lately state geologist of North Dakota, has accepted the professorship of geology in the State University of Iowa.

H. CHESTER CROUCH, professor of mechanical engineering at the University of Colorado, died on October 29, in Boulder, of typhoid fever at the age of thirty-two.

THE death is announced of Dr. Wilhelm Rimpau, of Schlanstadt, Germany, known for his work on plant breeding.

THE winter meeting of the American Chemical Society will be held at St. Louis, Mo., on December 28 and 29, in connection with the meeting of the American Association for the Advancement of Science.

THE Association of the American Agricultural Colleges and Experiment Stations will meet at Washington on November 17, 18, 19 and 20. The Association of Official Agricultural Chemists will meet at the same place on November 19 to 21.

A CONFERENCE on secondary education was held last week at Northwestern University.

THE second International Congress of Comparative Religions will be held at Bâsle next year.

THROUGH the gift of Dr. Thomas Biddle, the Philadelphia Academy of Natural Sciences has acquired in Berlin a valuable collection of anthropoid apes.

THE British committee appointed to consider the alleged physical deterioration of the people has held its first meeting under the chairmanship of Mr. Almeric W. FitzRoy.

The Botanical Gazette states that Mr. Barbour Lathrop, of Chicago, who has made several expeditions at his own expense to different

parts of the world, in search of valuable seeds and plants for introduction into America, has returned. He has employed on his various expeditions Mr. D. G. Fairchild, who now resumes his connection with the U. S. Department of Agriculture as one of its explorers. The countries visited this year with a view to more thorough exploration later by the department are Italy, Sicily, Tripoli, Tunis, Malta, Egypt, German East Africa, Zanzibar, Portuguese East Africa, Natal, Transvaal, Cape Colony, Grand Canary, Madeira, Portugal, Spain, Bohemia, Sweden, Denmark, Holland, Belgium and England. Such seeds and plants as were secured were given by Mr. Lathrop to the Department of Agriculture for propagation and distribution, and it is hoped that some of them may prove of great value to the country, repaying him for his patriotic and generous interest in increasing the variety of food and ornamental plants of America.

UNIVERSITY AND EDUCATIONAL NEWS.

At Cambridge University 866 new students have been admitted, an increase of sixteen over last year. At the University of London the number is 1,016, an increase of 400 over last year.

The London *Times* states that in connection with the Liverpool Institute of Comparative Pathology (Liverpool University), of which Professors Boyce and Sherrington are directors, a tropical veterinary department has been established. Its objects are to train veterinary and medical men in the tropical diseases of animals, to afford facilities for research in such diseases and organize expeditions, and to organize preventive measures in the tropics against diseases of animals. A memorandum on the subject has just been issued by the institute. It is pointed out that the advantages which Liverpool possesses for the study of tropical medicine are equally applicable to tropical veterinary medicine, there being an immense foreign cattle trade with the port. The Johnston Laboratory of Liverpool University, opened last May by Mr. Walter Long, M.P., contains the fully-equipped laboratories of the Institute of Comparative Pathology, of the Tropical School of Bio-Chemistry and of the Cancer Research Committee, and is directly connected with the departments of bacteriology, pathology and physiology. These subjects, closely associated in the new Thompson Yates and Johnston Laboratories, it is pointed out, mutually help one another, and thus increase the thoroughness of training and greatly promote the opportunities for research. The secretary of state for war has approved of the course laid down by the institute, and in future officers of the Army Veterinary Department will be sent to Liverpool for their special training, the Army Department paying the fees. The Liverpool School of Tropical Medicine also trains officers sent specially by the government. In connection with the new department it is desired to establish a practical post-graduate class in veterinary medicine and also a school of veterinary medicine. Firms interested in the cattle trade have subscribed a considerable sum towards the expenses involved, but further funds are needed.

Lord Goschen has been elected chancellor of Oxford University in succession to the late Lord Salisbury. Lord Strathcona, Canadian High Commissioner, has accepted the nomination to the chancellorship of Aberdeen University.

Mr. Henry Sanger Snow has resigned the presidency of the Brooklyn Polytechnic Institute.

At Williams College, Mr. Lorande Loss Woodruff, A.B. (Columbia, 1901), A.M., 1902, has been appointed assistant in biology.

Arthur E. Wade, Cornell College, 1901, has been promoted to the head of the Chemical Department of the Medical College of Sioux City, Iowa.

H. J. Turner, Ph.D. (Johns Hopkins), has been appointed instructor in chemistry at Tufts College.

Dr. E. Grimmich, professor of anatomy, has been elected rector of the German University of Prague.

Dr. W. Wirtinger, of Innsbrück, has been called to a chair of mathematics at Vienna.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 13, 1903.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ROBERT HENRY THURSTON.

ON October 25, 1903, Robert H. Thurston, director of the Sibley College of Cornell University and one of the editors of this JOURNAL, was stricken down with heart failure while awaiting in his library the coming of a few friends who had been invited to a dinner celebrating his sixty-fourth birthday. The news of his sudden death came as a great shock to the engineering profession throughout the United States, while to Cornell University the loss is one that seems irreparable for several years to come.

Robert H. Thurston was born in Providence, R. I., and was graduated from the engineering course of Brown University in 1859 with the degree of C.E. In 1861 he became an assistant engineer in the navy and served throughout the civil war, finally being promoted to the position of chief engineer of one of the monitors. In 1865 he was appointed an instructor in the U. S. Naval Academy at Annapolis, leaving that position in 1871 to accept the professorship of mechanical engineering in the Stevens Institute of Technology. This chair he held until 1885 when he was called to the directorship of the Sibley College of Mechanic Arts, a position which he filled until the day of his death.

The work of Professor Thurston at Stevens Institute and at Cornell University was most successful, it being characterized by great energy and executive ability,

by clear ideas of the needs of engineering education and by well-formed and definite plans for increasing its efficiency. When he took charge of Sibley College it had but sixty students, while now it has nearly a thousand, this being probably a larger registration of students pursuing mechanical and electrical courses than that of any other institution in the United States. Dr. Thurston's capacity for organization, his knowledge of all the details of the courses of study, his skill in managing the many professors and instructors under his charge and his untiring energy in work have always been an inspiring example to professors of engineering everywhere.

In 1873 Dr. Thurston was U. S. Commissioner to the Vienna exposition and wrote the volume on machinery. In 1875 he was appointed a member of the U. S. board to test metals, and became its most active member during the three years of its existence. In connection with this work he devised a machine for torsional tests and made numerous investigations in the mechanics of materials, the most important one being that which established the fact that the elastic strength of wrought iron or steel is increased by stressing the material beyond that limit. In 1883 he published a work in three volumes entitled 'The Materials of Engineering,' which has been of much value to the engineering profession; an abridged edition of this work called 'Materials of Construction' has been widely used as a text-book in technical schools.

While at Stevens Institute Dr. Thurston instituted tests of the efficiency of boilers and engines and continued these studies throughout his life, becoming one of the highest American authorities on thermodynamics. His books entitled 'Handbook of Engine and Boiler Trials,' 'Stationary Steam Engines' and 'Boiler Explosions' have had a wide circulation, while his 'Manual of the Steam Engine,' a work in three volumes, has had the high honor of having appeared at Paris in a French translation. He also made many experiments on the friction of machinery, the results of which are given in his books 'Friction and Lubrication' and 'Friction and Lost Work.' Other books which appeared from his ready pen were 'The Animal as a Machine and Prime Motor' and 'Life of Robert Fulton,' while his contributions to scientific and engineering periodicals are numbered by the hundreds.

Professor Thurston was a member of many scientific and engineering societies, both American and foreign, and always maintained an active interest in their work. In 1880 he was one of the founders of the American Society of Mechanical Engineers and its first president, and his counsel has always been highly valued by the governing board of this society. The presidency of many other societies was often urged upon him by his friends, but he seemed to have a marked aversion to being regarded as a candidate, although always ready to assist in the scientific or professional work of such organizations.

The connection of Professor Thurston with the American Association for the Advancement of Science began with his election in 1874, and in the following year he was made a fellow. In 1877 and 1878 he was vice-president of Section A, which at that time included mathematics, physics and chemistry, while the remaining work of the association was grouped as natural history in Section B. In 1884, when the association had expanded to six sections, Professor Thurston was vice-president of Section D which includes mechanical science and engineering, and he always took a deep interest in its work.

When Science began its new series in 1895, an editorial committee was organized

covering essentially the same departments as those of the sections of the American association, and Professor Thurston accepted the charge of the department of engineering. His contributions to the pages of this Journal have been many and are well known to our readers. His work, which never flagged, continued to the last, for on the day of his death an article signed R. H. T. was in type and it appeared in the issue which contained the obituary announcement.

It is yet too early to speak with accurate judgment regarding the final value of the scientific and engineering work of Professor Thurston. There can be no doubt, however, that it was of great benefit to mankind, for he made engineers better scientists, promoted engineering education, helped to put engineering upon a higher professional plane, and constantly was on the watch to dispel the fogs of prejudice by help of the truths of science. His alma mater conferred upon him the degree of LL.D., and Stevens Institute devised the degree of doctor of engineering to do him special honor. In personal disposition he was quiet and retiring, but yet affable and kindly. His work was done with method and precision, and he was always most untiring to serve the interests of the educational institution with which he was connected. It is announced that the authorities of Cornell University propose to commemorate his services by the erection of a costly laboratory as a memorial, the same to be called Thurston Hall.

*SIMULTANEOUS SOLAR AND TERRESTRIAL CHANGES.**

There are very many cases recorded in the history of science in which we find that the most valuable and important applications have arisen from the study of the ideally useless. Long period weather forecasting, which at last seems to be coming into the region of practical politics as a result of the observation of solar changes, is another example of this sequence.

The first indications of these changes on the sun, to which I have referred, are matters of very ancient history, and so also is the origin of some of the branches of observation on which the study of them depends.

I will begin by referring to these and to the conclusions arrived at in relation to simultaneous solar and terrestrial changes previously to the last 25 years.

The facts that there are sometimes spots on the sun, and that there is a magnetic force which acts upon a needle, seem to have been known to the ancient Chinese. In more modern times the enquiries with which we are now concerned, date from the times of Galileo (1564–1642) and Kepler (1571–1630).

To Galileo, Fabricius and Scheiner we owe the first telescopic observations of the spots on the sun; to Kepler, the basis of spectrum analysis, which has not only revealed to us the chemistry of the sun and of its spots, but enables us to study daily other phenomena, the solar prominences, which will in all probability turn out to be more important for practical purposes than the spots themselves.

It is only quite recently that the importance of the study of the prominences in this direction has been indicated, so that we have to deal, in the first instance, with a long period of years in which only the spots and their terrestrial echoes were in question.

According to Professor Wolf (as quoted by Professor Köppen), Riccioli, in 1651, shortly after the first discovery of sun spots, surmised that some coincidence

* Report, International Committee, Southport, 1903.

might exist between them and terrestrial weather changes.*

In the first year of the last century, Sir Wm. Herschel drew attention to this subject.† He wrote:

The first thing which appears from astronomical observations of the sun is that the periods of the disappearance of spots on the sun are of much greater duration than those of their appearance.

With regard to the contemporary severity and mildness of the seasons, it will hardly be necessary to remark that nothing decisive can be obtained. An indirect source of information, however, is opened to us by applying to the influence of sunbeams on the vegetation of wheat in this country. I do not mean to say that this is a real criterion of the quantity of light and heat emitted by the sun, much less will the price of this article completely represent the scarcity or abundance of the absolute produce of the country.

On reviewing the period 1650–1713, it seems probable, from the prevailing price of wheat, that some temporary scarcity or defect of vegetation has generally taken place when the sun has been *without* those appearances which we surmise to be symptoms of a copious emission of light and heat.

To those acquainted with agriculture who may remark that wheat is well-known to grow in climates much colder than ours, and that a proper distribution of rain and dry weather are probably of much greater consequence than the absolute quantity of light and heat derived from the sun, I shall only suggest that those very circumstances of proper alternations of rain and dry weather and wind, etc., favorable to vegetation, may possibly depend on a certain quantity of sunbeams being supplied to them.

Herschel's suggestion was a daring one, for however perfect our national statistics may have been in relation to the price of wheat, there was nowhere kept up a continuous record of the changes observable on the sun's surface, nor had there been any serious attempt made to determine the law underlying them.

In 1825 this serious attempt was made, and by Schwabe of Dessau, who discovered a cycle of about eleven years in the solar changes. Wolf afterwards took up the question.

Herschell had associated the variation in the number of spots with that in the price of corn, the connecting link being sunshine or weather. It was to him a question of meteorology.

A year after the publication of Herschel's papers, Wollaston extended the early spectrum work of Kepler and Newton by discovering that in the solar spectrum there were many dark lines; these were for the first time mapped by Fraunhofer in 1814.

Soon after 1850 it became a question of the connection of sun spots with terrestrial magnetism as well as with meteorology. A new idea was introduced.

Lamont, Sabine and Allan Broun discovered that there was a well marked coincidence between the variations of magnetic effects, as observed on the surface of our planet by delicately suspended magnets, and the quantity of spotted area observed on the sun. This in later telegraphic days is not merely a pious opinion which does not interest anybody, because, when the magnetic changes are very considerable and the disturbances arrive at a maximum, it is very difficult to get a telegram from London to Brighton.

The period around the year 1860 was rendered ever memorable by a still further extension of Kepler's and Newton's work, which at once explained the dark lines observed in the solar spectrum by Wollaston and Fraunhofer.

Hitherto undreamt-of attacks on the nature of the sun became possible. The names of Kirchhoff, Bunsen, Angström, Stokes, Balfour Stewart will go for very long down the stream of time, because they showed us that in spectrum analysis we had the power of practically conversing, chemically, with the distant worlds in

* Blandford, Bengal, *Asiat. Soc. Journ.* 65; Part II., 1875, p. 22.

† *Phil. Trans.*, 1801, p. 265.

space, and these distant worlds, of course, included the sun, although it is practically our neighbor.

It was now established that the solar radiation came from the incandescence of metallic vapors and gases in the sun's atmosphere, the metals and gases being for the most part those with which we are familiar on the earth. Not only was a high temperature demonstrated in this way, but it was further shown that above the sun's apparent surface there was an absorbing atmosphere, consisting of vapors cooler than those below, but yet hot enough to be composed of the steam of iron and other metals.

In 1865, De la Rue, Stewart and others, in an attempt to get the periodicity of the solar phenomena still more accurately determined, started work at Kew; while the former observations were carried on by Schwabe and Wolf by the eye, photography, which was then being introduced into astronomical work by the labors of Warren De la Rue, was for the first time now utilized, and a picture of the sun was taken each day.

In 1866 a new method of observing solar changes, which consisted in throwing an image of the sun on the slit plate of a spectroscope, revealed the fact that the spectra of spots differed from that of the photosphere generally; certain lines were widened in the spot spectrum.*

In 1867 a connection between changes in spotted area and in terrestrial temperatures was pointed out by Baxendell.† He noticed a distinct and very striking relation between the number of sun spots and the ratio which exists between the difference of the mean maximum temperature of solar radiation and the mean maximum air temperature on the one hand, and that of the mean temperature of the air and of evaporation on the other.

In 1868 a spectroscopic method was discovered of observing in full daylight the 'prominences' or 'red flames' which hitherto had only been glimpsed during eclipses, and it was established that, closely surrounding the sun ordinarily seen, there was an envelope, named the chromosphere, of incandescent gases and vapors, hydrogen and a new substance named helium chief among them.*

Many spectroscopic observations made on the spots and prominences about this time indicated great changes in the solar temperature in different regions, and possibly, therefore, changes in the amount of heat radiated earthwards. From the changes thus actually seen it was easy to imagine that there might be a cycle of terrestrial changes depending no longer on the sun's presentation to us in its daily and yearly rounds, but on physical changes in the sun itself, requiring, perhaps, many years to accomplish.

In 1869, Janssen showed† that by a special arrangement of the spectroscope an image of the sun, showing the prominences both on the disc and surrounding it, might be obtained.

It was not very long before it was found that the reaction of these solar changes on the earth was not so limited as had formerly been thought. This was an idea started by Dr. Stone of the Royal Observatory at the Cape of Good Hope, Piazzi Smyth of the Royal Observatory of Edinburgh, and others, about the years 1870 and 1871, but the most striking imperial contribution to the matter we owe to the labors of a distinguished meteorologist, Dr. Meldrum, director of the observatory at Mauritius, which has since become the Royal Alfred

* Lockyer, *Proc. Roy. Soc.*, October 11, 1866.

† *Memoirs of the Manchester Lit. and Phil. Soc.*, Third Series, Vol. IV., pp. 128 et seq.

* Lockyer, *Proc. Roy. Soc.*, October 20, 1868.

† *Comptes Rendus*, Vol. LXVIII. (1869), pp. 367 et seq.

Observatory. He showed that the number of wrecks which came into the harbor of the Mauritius and the number of cyclones observed in the Indian Ocean could enable any one to determine the number of spots that were on the sun about the time. The Mauritius is most admirably suited for the making of these observations, because the Tropics are really the right region in which to try and estimate the possibilities of this solar action. Meldrum found, in fact, that the maximum number of cyclones was associated with the maximum number of sun spots. He wrote:*

> During the period 1847–72 it is found that some years have been remarkable for a frequency, and others for a comparative absence of cyclones.
> 1847–51 were characterized by cyclone frequency.
> 1852–57 were characterized by comparative calm.
> 1858–63 were characterized by cyclone frequency.
> 1864–68 were characterized by decrease.
> 1868–72 were characterized by great increase.
>
> It will be seen that the years correspond with the maxima and minima epochs of sun spots. It appears to me that there is more than a mere coincidence as to time.
>
> The numbers of wrecks during these periods also show a similarly regulated frequency.

Poey, investigating shortly afterwards the cyclone condition in the West Indies,† found that the greater number of years of maxima of storms fall from six months to two years, at the most, after the years of maxima of solar spots.

Out of twelve maxima of storms, ten coincide with maxima periods of spots. Out of five minima of storms, five coincide with minima of spots.

It will be seen that the results from both the East and West Indies are the same. Next came the question of a rainfall cycle corresponding to the solar spots.‡

When I was preparing to go to India, in 1871, to observe the eclipse, Mr. Ferguson, the editor of the *Ceylon Observer*, who happened to be in London, informed me that everybody in Ceylon recognized a cycle of about thirteen years or so, in the intensity of the monsoon—that the rainfall and cloudy weather were more intense every thirteen years or so. This, of course, set one, interested in solar matters, thinking, and I said to him: "But are you sure the cycle recurs every thirteen years, are you sure it is not every eleven years?" adding, as my reason, that the sun spot period was one of eleven years or thereabouts, and that in the regular weather of the Tropics, if anywhere, this should come out.

It afterwards turned out that the period in Ceylon was really of eleven years, five or six years dry, and five or six years wet, and that a longer period of about thirty-three years was recognized.

Mr. Meldrum passed from cyclones to rainfall by a very obvious step, because cyclones are generally accompanied by torrential rains. A study of the rainfalls of Port Louis, Brisbane and Adelaide led him to the conclusion that a case had been made out for a supposed periodicity.

On my return from India I looked up the Cape and Madras records for the periods available, and found that they followed suit, hence I quite agreed with Dr. Meldrum that investigations were desirable, and I wrote as follows:*

> Surely in meteorology, as in astronomy, the thing to hunt down is a cycle, and if that is not to be found in the temperate zone, then go to frigid zones, or the torrid zones and look for it, and if found, then above all things, and in whatever manner, lay hold of, study it, record it, and see what it means. If there is no cycle, then despair for a time if you will, but yet plant firmly your science on a physical basis, as Dr. Balfour Stewart long ago suggested, before, to the infinite detriment of English science, he left the Meteorological Observatory at Kew; and having got such a basis as this, wait for results. In the absence of these methods, statements of what is happening to a blackened bulb in vacuo, or its

* *Nature*, Vol. VI., p. 357, 1872.

† *Comptes Rendus*, November 24, 1873, p. 1222.

‡ 'Solar Physics' (Lockyer, 1874), p. 425.

* 'Solar Physics, pp. 424–5.

companion exposed to the sky, is, for research purposes, work of the tenth order of importance.

With reference chiefly to Dr. Meldrum's paper, I added:

Surely here is evidence enough, evidence which should no longer allow us to deceive ourselves as to the present state of meteorology. A most important cycle has been discovered, analogous in most respects to the Saros discovered by the astronomers of old, indeed, in more respects than one, may the eleven yearly period be called the Saros of meteorology, and as the astronomers of old were profoundly ignorant of the true cause of the Saros period, so the meteorologists of the present day are profoundly ignorant of the true nature of the connection between the sun and the earth.

What, therefore, is necessary in order to discover the true nature of this nexus? Two things are necessary, and they are these. In the first place, we must obtain an accurate knowledge of the currents of the sun, and secondly, we must obtain an accurate knowledge of the currents of the earth. The former of these demands the united efforts of photography and spectrum analysis, and the second of these demands the pursuit of meteorology as a physical science, and not as a mere collection of weather statistics. When these demands are met—and in spite of the Mrs. Partingtons who are endeavoring to prevent this, they will soon be met—we shall have a science of meteorology placed on a firm basis—the meteorology of the future.*

At this time the Indian authorities were quite alive to the importance of such investigations as these. India is in the tropics, India is a child of the sun, the inhabitants depend almost entirely upon the beneficent rains which seemed, in some way or another, to depend upon solar action. India also had then the germs of one of the best equipped meteorological organizations which exist on the surface of the planet, and the meteorologists felt that there was something behind their meteorological registers which might be assisted by taking a very official step and going to headquarters, headquarters being the sun. When I was in India, in 1872, Lord Mayo, the then Viceroy, did me the honor to ask me to go to Simla with a view of choosing a site for a proposed Solar Physics Observatory. That is thirty years ago! Unfortunately, I was secretary of the Duke of Devonshire's Commission, which was then sitting, and I could not get leave, and, therefore, could not go; the scheme, which was then before the Indian authorities—which, if I may say so, was altogether grandiose and extravagant—fell through.

In 1873, the idea of the possible connection of solar and magnetic changes had got so far that the magnetic and meteorological department of the Royal Observatory at Greenwich, which had been established in 1838, received an important addition. A photo-heliograph was set up in order to continue the daily photographic record of the sun's surface, begun at Kew in 1865.

In the same year Köppen found that the maximum temperature occurs in the years of sun spot minima and the reverse, years with many spots are cool years.*

Of special importance for the connection between the temperature on the earth's surface with the sun's spotted area is the fact that the temperature curve (mean number for the whole earth) and the curve representing the sun-spotted area is identical in all the irregularities.

In the tropics in the

Year before the sun spot *Min.*, the temperature is 0.41° higher than the mean.

Year before the sun spot *Max.*, the temperature is 0.32° lower than the mean.

The variation is thus 0.73°.

* I very much regret that, in the article quoted, my reference to Carlyle's German 'Dry as dust,' as a patient enquirer who would eventually apportion credit to all meteorological workers, has been misunderstood by some of my German friends. Relying on imperfect dictionaries, which have told them that a mere 'bookworm' was meant, they have missed the high compliment I intended to pay them.

* W. Köppen, 'Uber mehrjährige Perioden der Witterung,' *Zeitschrift f. Meteorologie*, Bd. VIII., 1873, pp. 241–248 and 257–268.

By this time spectroscopic observations of the solar changes had proved that the sun was hottest when there were most spots, thereby upsetting the old idea that the spots acted as screens and reduced the radiation at sun-spot maximum. Köppen's result, therefore, was a paradox, and was thus explained by Blanford.*

The temperatures dealt with by Professor Köppen are of course those of the lowest stratum of the atmosphere at land stations, and must be determined *not by the quantity of heat that falls on the exterior of the planet, but on that which penetrates to the earth's surface, chiefly to the land surface of the globe.* The greater part of the earth's surface being, however, one of water, the principal immediate effect of the increased heat must be the increase of evaporation, and therefore, as a subsequent process, the cloud and the rainfall. Now a cloudy atmosphere intercepts the greater part of the solar heat, and the re-evaporation of the fallen rain lowers the temperature of the surface from which it evaporates and that of the stratum of air in contact with it. The heat liberated by cloud condensation doubtless raises the temperature of the air at the altitude of the cloudy stratum; but at the same time we have two causes at work, equally tending to depress that of the lowest stratum. As a consequence, an increased formation of vapor, and therefore of rain, following on an increase of radiation, might be expected to coincide with a low air-temperature on the surface of the land.†

The next important advance had to do with atmospheric pressure. In 1875, Mr. C. Chambers, the director of the Bombay Observatory, found that

The variation of the yearly mean barometric pressure at Bombay shows a periodicity nearly corresponding in duration with the decennial sun-spot period.‡

The years round 1875 were rendered very important by the number of new organizations established to record and demonstrate various classes of observations with which we are concerned in this short history. Meteorological enquiries on a large scale were organized at home and in India, and observatories were established at Potsdam, Paris and London, with the main object of studying solar changes. At the same time steps were taken to resume observations in the tropics. It is not out of place here to make a brief reference to what was done in Britain and India.

The government took this action in consequence of a strong recommendation of the Royal Commission on Science, presided over by the late Duke of Devonshire, of the establishment by the state of an Observatory of Solar Physics in which enquiries relating to the nature of the sun and its changes should be fostered and various investigations which were necessary should be carried on.

The commission also proposed that similar institutions should be established in various parts of the empire.

The ground on which the Royal Commission, and subsequently a memorial presented to the government by the British Association, urged this new departure was that, in the opinion of a considerable number of scientific men, there was a more or less intimate connection between the state of the sun's surface and the meteorology of the earth; and they called attention to the fact that recent independent investigations on the part of several persons had led them to the conclusion that there was a similarity between the sun-spot period, periods of famine in India, and cyclones in the Indian Ocean. The memorialists concluded by saying:

We remind your lordships that this important and practical scientific question can not be set definitely at rest without the aid of some such institution as that the establishment of which we now urge.

The Lords of the Committee of Council on Education referred this memorial to a

* Blanford, Bengal, *Asiat. Soc. Journ.*, 1875.

† See also Blanford, *Nature*, April 23, 1891, Vol. 43, p. 583.

‡ 'Meteorology,' Bombay Presidency, August, 1875, S. 26, p. 12.

committee, consisting of Professor Stokes, Professor Balfour Stewart and General Strachey, for their opinion as to whether a commencement might not be made to give effect to the proposals of the memorialists by utilizing the chemical and physical laboratories at South Kensington, as the proposed observatory must be more chemical and physical than astronomical. The following paragraph appeared in the terms of reference:

Although we are not at present in a position to consider the establishment of a physical observatory on a comprehensive scale, we believe that some advantage can be gained if a new class of observations can be made with the means at command, since the best method of conducting a physical observatory may thus be worked out experimentally, and an outlay eventually avoided which, without such experience, might have been considered necessary.

While the discussion as to the establishment of a solar physics observatory in this country was going on, Lord Salisbury, who was then Secretary of State for India, permitted me to send him a memorandum on this subject. In it I pointed out that what we wanted, especially in reference to solar enquiries, was to learn, day by day, what the sun was really doing, which India and other tropical countries always could tell us, while it seemed almost impossible that we should ever get sufficiently continuous records in England.

I gave the following extracts:

Solar research is now being specially carried on in Europe at—

1. Potsdam, in the new Sonnenwarte.
2. Paris, in the new physical observatory.
3. Rome and Palermo.
4. South Kensington, in connection with the Science and Art Department.
5. At Greenwich, Wilna, and other places it is carried on in a less special way.

In these European observatories, however, especially in the more northern ones, we are attempting to make bricks without straw, that is, the climate is such that the observations are often interrupted, at times for weeks together, while, in addition to this, in winter the sun's altitude is so small that fine work is impossible.

While this state of things holds in Europe, in India, on the other hand, one has an unlimited and constant supply of the *raw material*, by which I mean that here one can, if one chooses, obtain observations of the finest quality in sufficient quantity all the year round. I may even go further, and say that, limiting my remark to English ground, we have in India a *monopoly* of the raw material.

The prayer of the memorandum was granted, and shortly afterwards I had the pleasure of sending out one of my assistants to India. Unfortunately, he died soon after the first series of daily photographs of the sun had been commenced, but eventually the Trigonometrical Survey Department took the matter up, an observatory was built at Dehra Dun, and India began its work, and I am thankful to say that it has gone on continuously ever since.

It was not till 1879, and after a letter from the Duke of Devonshire, that a sum of £500 was taken on the estimates to replace the assistance formerly obtained by myself from the Government Grant Fund administered by the Royal Society, and to allow of more research work being undertaken. At the same time, the Solar Physics Committee was appointed. The object sought was to make trial of methods of observation, to collect and discuss results, to bring together all existing information on the subject, and to endeavor to obtain complete series of observations along the most important lines.

This state action was taken because the sun has to be studied, if studied at all, continuously, because it is ever changing, and the more we study it the longer are the cycles which we find to be involved; hence, all enquiries into its nature must be on an imperial basis. Individuals die, nations remain. Nor is this all. Observatories are not only wanted in the centers of intellectual activity where research can be conducted in a scientific atmosphere, but

there must be others to obtain the necessary observations in those favored regions of our planet in which the maximum of sunshine can be depended upon.

The then astronomer royal, Sir George Airy, was most sympathetic, and as a result of this state action, the little observatory at South Kensington was shortly afterwards enlarged; it has considerably grown since then, but it is still in the experimental stage. Although, perhaps, I am not the one to say it, I am prepared to take the responsibility of stating that it is now one of the best equipped for its special work in the world. It certainly is the shabbiest to look at. Irreverent comparisons have been made even in the House of Commons; the general appearance of its wood and canvas huts having been likened to that of a more or less disreputable looking traveling menagerie, but, at all events, it is instrumentally efficient, and that for the present must be sufficient.

During the last quarter of a century a great deal of work has been going on, and the colonies and dependencies of Britain have also been doing yeoman service; very little has been said about it, because not all departments are in the habit of advertising themselves, and Blue Books are not as a rule light reading. In the first place, the Indian daily photographic record, which was weak during a month or two during the S.W. monsoon, was supplemented by the erection of a duplicate instrument at the Mauritius; and I am again thankful to say that the work has gone on at the Mauritius continuously since. Thus we have now two tropical records, which, taken together, may be described as absolutely continuous, of solar changes sent to us in the most imperial fashion by two observatories. Another appeal was made to Australia. For a time records were sent us, but I am sorry to say that after a time they ceased.

These records are sent regularly with every precaution against loss, to the observatory at South Kensington; and for the days when no photographs have been taken at Greenwich the necessary photographs are transmitted there, where they are reduced in continuation of the record commenced in 1873 there, in succession to Kew.

What has been the result of this? The late astronomer royal took up this work at Greenwich in 1873. In 1874, 1875, 1876, 1877, 1878, the average number of days on which it was possible to obtain photographs in each year was a little over 160, the exact figures being 159, 161, 167, 171, 149. This was Greenwich working alone, national work.

Next, we come to the imperial work. Selecting years at random, and dealing with 1889 to 1893, I find that we obtained photographs of the sun in 1889 for every day in the year except five, in 1890, for every day except four, in 1891, for every day except two. It is easy to understand that with such a magnificently complete record as this the study of solar physics was enormously improved.

Very fortunately for science, even before these steps were being taken to secure a continuous record of the spotted area, Professor Respighi (1869) and Professor Tacchini (1872) had commenced at Rome a daily record of the solar prominences and of the latitudes at which they appeared at different times.

I pass on to some of the most important work done during the last quarter of a century, only referring to the results obtained which bear upon the connection between solar and terrestrial changes.

Many important advances were made in 1878.

Mr. F. Chambers, in continuing his studies on the Indian barometer, found* a remarkable degree of resemblance in the progression of barometric pressure during

* *Nature*, Vol. XVIII., p. 567.

summer, winter and year, and sun spots from year to year; but he noticed that the barometric curve *lags* behind the sun-spot curve, particularly in the years of maxima of sun spots. The winter curve is more regular than the summer one, probably because the weather generally in India is more settled in the winter than in the summer; but on the whole the two curves support each other in having a *low pressure* about the time of *sun-spot maximum*, and a high pressure about the time of sun-spot minimum. We may, therefore, conclude that the *sun is hottest* about the time when the *spots are at a maximum*. He added, that these results appear to harmonize well with the decennial variations of the rainfall in India, and to throw light upon the inverse variation (compared with the sun spots) of the winter rainfall of northern India.

Dr. Allan Broun also, in a discussion of Indian barometric readings, found that the years of greatest and least pressure are probably the same for all India, and that, therefore, the relation established by Mr. Chambers for Bombay holds for all India.*

I next pass to rainfall. Dr. Meldrum, returning to his rainfall studies, found that †

> There is a remarkable coincidence between the rainfall and sun-spot variation at Edinburgh, much more remarkable than that at Madras. The years of maximum and minimum rainfall, and sun spots for the mean cycles, coincide, and on the whole there is a regular gradation from minimum to maximum, and from maximum to the next minimum.

The minimum rainfall occurred, on an average, in the year immediately preceding the year of maximum sun spots.

The results of these investigations show that the rainfall of 54 stations in Great Britain from 1824–1867 was .75 inches *below mean* when sun spots were at a minimum, and .90 inches *above mean* when sun spots were at a maximum.

For the 34 stations in America, the corresponding numbers were .94 inch in 1.13 inches.

In the report of the Meteorological Department of the government of India, published this year (1878), the following reference to solar action occurs:

> The following are the main important inferences that the meteorology of India in the years 1877–1878 appears to suggest, if not to establish:
>
> There is a tendency at the minimum sun-spot periods to prolonged excessive pressure over India, and to an unusual development of the winter rains, and to the occurrence of abnormally heavy snowfall over the Himalayan region. * * * This appears also to be accompanied by a weak southwest monsoon.

In 1880 the relation of India famines and the barometer was first fully treated by Mr. F. Chambers, the meteorological reporter for western India.* He concluded from his enquiry that there is some intimate relation between the variations of *sun spots, barometric pressure* and *rainfall;* and as famines in general are induced by a deficiency of rain, it is probable that they also may be added to the above list of connected phenomena.

Commencing with the daily abnormal variations observed at several stations in western India, it was found that as the time over which an abnormal barometric fluctuation extended became longer and longer, the range of the fluctuation became more and more uniform at the various stations, thus leading to the conclusion that the '*abnormal variations of long duration affect a very wide area.*' For testing this, the conditions of Batavia were compared with those at Bombay, and the results showed a striking coincidence, the curves obtained for the two places being almost identical in form, but with this remarkable difference: the curve for Batavia was

* *Nature*, Vol. XIX., p. 6.

† *Nature*, Vol. XVIII., p. 565.

* *Nature*, Vol. XXIII., p. 109.

found *to lag* very persistently about one month *behind* the Bombay curve.

Similar results were then worked out for other stations. St. Helena, Mauritius, Madras, Calcutta and Zi-ka-wei. On comparing the curves obtained for these various places, though a strong resemblance in form betwen all the curves is observed, there is also strong evidence of a want of simultaneity in the barometric movements at different stations, and that as a rule the changes take place at the *more westerly stations* several months *earlier than* at the more *easterly ones.*

Thus, on comparing the curves for St. Helena and Madras from 1841–1846, the latter sometimes lagged behind the former as much as six months, and for Bombay and Calcutta the corresponding difference was often upwards of six months.

The facts suggested to him long atmospheric waves (if such they may be called) traveling at a very slow and variable rate round the earth, from *west to east,* like the cyclones of the extra-tropical latitudes.

With special reference to famines, he remarked that, on comparing the dates of all the severe famines which have occurred in India since 1841, widespread and severe famines are generally accompanied or immediately preceded by waves of high barometric pressure. He suggested, therefore, that intimation of the approach of famines might be obtained in two ways:

(*a*) By regular observations of the solar spotted area, and early reductions of the observations, so as to obtain early information of current changes going on in the sun.

(*b*) By barometric observations at stations differing widely in longitude, and the early communications of the results to stations situated to the eastward.

In the same year, Dr. H. F. Blandford discovered that*:

Between Russia and Western Siberia on the one hand, and the Indo-Malayan region on the other, there is a reciprocating and cyclical oscillation of barometric pressure, of such a character that the pressure is at a maximum in *Western Siberia* and *Russia* about the epoch of maximum sun-spots, and in the *Indo-Malayan* area at that of minimum sun-spots.

Up to 1881, the general idea had been that there was a great difference between the meteorological conditions at the maximum and minimum of the sun-spot curve, but the more numerous and more accurate series of observations available in the year in question revealed to Meldrum 'extreme oscillations of weather changes in different places at the turning points of the curves representing the increase and decrease of solar activity.'

This was a most important change of front. Not the maximum only, but both the maximum and minimum had to be considered.*

In relation to these pressure changes he wrote as follows:†

Among the best established variations in terrestrial meteorology which conform to the sun-spot cycle, are those of tropical cyclones, and the general rainfall of the globe, both of which imply a corresponding variation in evaporation and the condensation of vapor. Now the variation of pressure with which we have to deal evidently has its seat in the higher (probably the cloud-forming) strata of the atmosphere. This is not only illustrated in the present instance by the observed relative excess of pressure at the hill stations as compared with the plains, but also follows as a general law from the fact established by Gautier and Köppen, viz., that the temperature of the lowest stratum varies in a manner antagonistic to the observed variation of pressure. It is then a reasonable inference that the principal agency in producing the observed reduction of pressure at the epoch of sun-spot maximum is the more copious production and ascent of vapor, which may operate in three different ways. First, by displacing air the density of which is three eighths greater; second, by evolving latent heat in its condensation; and thirdly, by causing ascend-

* *Nature,* Vol. XXI., p. 480.

* 'Relations of Weather and Mortality, and in the Climatic Effect of Forests.'

† *Nature,* XXI., p. 482.

ing currents, and thus reducing dynamically the pressure of the atmosphere as a whole. The first and second of these processes do not indeed directly reduce the pressure but only the density of the air stratum while they increase its volume. In order, therefore, that the observed effect may follow, a portion of the higher atmosphere must be removed, and this will necessarily flow away to regions where the production of vapor is at a minimum, viz., the polar and cooler portions of the temperature zones, and more especially those where a cold dry land surface radiates rapidly under a winter sky. Such an expanse is the great northern plain of European Russia and Western Siberia north of the Altai.

In 1886 we got the first fruits of the observations of the widened lines in sun spots, which had been obtained on a definite plan, since 1879. The changes which occurred from a spot-minimum to a spot-maximum, and some distance beyond, had therefore been recorded. The changes were most marked, showing a great change in the chemistry of the spots at these times. At minimum the lines chiefly widened were those of iron and some other metals, but at the maximum the lines widened were classed as 'unknown,' because they had not been recorded in the spectra of the terrestrial elements. It was reasonable to suppose, therefore, that the sun was not only hotter at maximum, but hot enough to dissociate iron vapors.*

In 1891 Janssen's suggestion of 1869 was brought into a practical shape for observatory work, by Hale and Deslandres,† and the prominences on the sun's disc, and surrounding it, were photographed in full daylight by using only the light radiated by the calcium vapor, which they always contain.

By the year 1900 we had accumulated, at South Kensington, observations of the widened lines for a period of over 20 years. There was a curious break in the regularity of the results obtained after 1894, and the Indian meteorologists reported contemporaneous irregularities in the Indian rainfall.

I determined, therefore, to make a connected enquiry into both these classes of phenomena. Thanks to the establishment of the Indian Meteorological Department in 1875 we had rainfall tables extending over a quarter of a century, and in the tropics, where the problems might be taken as of the simplest, to compare with the new solar data.

I have already stated that in the preliminary discussion of the most widened lines observed in the sun spots up to the year 1885, a most remarkable difference was observed in the lines observed at sun-spot maximum and minimum. This continued till about 1895, another ten years. As the curve of iron lines went up, the curve of 'unknown' lines came down; there were therefore *crossings* of the curves which might, on the hypothesis before referred to, be taken as the times at which the temperature of the solar system had a mean value. These crossings turned out to be about half-way between the maxima and minima of the spotted area which had to be considered as the times at which the sun was hotter and colder than the mean.

We were then brought into the presence of three well-marked stages of solar temperature—it was no longer a question merely of spots and no spots, but of heat pulses.

The next point was to study these heat pulses in relation to the Indian rainfall, and it was found that in many parts of India the plus and minus heat pulses on the sun, which, of course, occurred immediately after the time of mean temperature, when the sun was getting either hotter or colder, were accompanied by pulses of rain in the Indian Ocean and the surrounding land. It was next found, from a study of the Indian Famine Committee's reports,

* *Proc. Royal Soc.*, 1886, p. 353.

† *Comptes Rendus*, August 17, 1891.

that the famines which have devastated India during the last half century have occurred in the intervals between the pulses.

In 1902, with a view of getting more light on the important issues raised by the comparison of the solar heat pulses and the Indian rainfall, I determined to reduce the observations of prominences made by Tacchini at the Observatory of the Collegio Romano since 1874, and compare the Indian meteorological conditions with them. The reason for this step was that the admirable photographs of the prominences on the solar disc, published by Hale and Deslandres, showed the extensive area over which they were distributed. An argument which has been used against the possible connection between solar and terrestrial changes was based upon the small area covered by spots. In 1877 Eliot wrote as follows:*

> So far as can be judged from the magnitude of the sun spots, the cyclical variation of the magnitude of the sun's face free from spots is very small compared with the surface itself; and consequently, according to mathematical principle, the effect on the elements of meteorological observations for the whole earth ought to be small.

Now the photographs, to which I have referred, exhibited broad bands of prominences extending almost across the whole disc, and if we assume two belts of prominences, N. and S., 10° wide, with their centers over latitude 16°, a sixth of the sun's hemisphere would be in a state of disturbance. Hence it followed that the prominence effect, when fully studied, might be much more striking and important than that produced by spots.

The prior work in connection with the Indian rainfall had shown not only that there was a close connection between pressure and rainfall, but that the pressure was much the more constant element over the different areas. The comparison with the prominences obtained from the discussion of Tacchini's results was in the first instance compared with the Indian pressure curve.

The result was magnificent. In addition to the well-marked prominence maximum at the maximum of the spotted area, there were others corresponding approximately with the 'crossings' of the widened lines, and all were re-echoed by the Indian barometers!

The sun-spot cycle of eleven years gave way to a prominence cycle of about 3.7 years, and by this interval, as a rule, are the Indian pressures separated.

To see whether such a striking and important result as this was limited to Indian ground, the magnificent series of pressure obtained at Cordoba in South America were studied. Here the same effect was also most marked, but with the important difference that the curves were inverted; that is, high pressure years in India were represented by low pressure years in Cordoba. In order to extend the Indian and Cordoba areas and see how far these conditions prevailed, the pressure variations of stations as widely distributed as possible were examined. The result of this inquiry showed that the world might be divided roughly into two portions. The Indian area was found to extend to Australia, East Indies, Asiatic Russia, Mauritius, Egypt, East Africa and Europe, while the Cordoba region might be said to include not only South and Central America, but the United States and Canada, extending further west than Honolulu.

This discovery of this barometric surge, which has been corroborated since by Professor Bigelow, was an important advance, and will enable the investigator to connect up regions that undergo similar pressure changes.

In addition to the two periods, namely, 11 and 3.7 years, mentioned above, Brück-

* 'Report on the Meteorology of India,' 1877, p. 2.

ner* has pointed out that there is a long period weather variation. His discussion of all the available data of pressure, rainfall, temperature, etc., led him to conclude that there is a periodical variation in the climates over the whole earth, the mean length of this period being about 35 years.

Since this work, a recent discussion of the sun-spot data by Dr. W. J. S. Lockyer† has brought to light a similar long period, and this has taught us that each eleven-year cycle is different from the one immediately preceding and that following it.

A further inquiry into the distribution of the solar prominences, as observed by Respighi, Secchi Tacchini, Ricco, and Mascari,‡ has resulted in increasing our knowledge of the circulation of the solar atmosphere. The centers of prominence action, or the centers of the prominence belts, have a tendency to move from low to high latitudes, the opposite of spots; generally speaking, two belts in each hemisphere exist for some time, then they couple up and move towards the solar poles, while in the meantime a new belt begins to form in low latitudes.§

The existence of prominences in the polar regions is coincident with great magnetic disturbances on the earth, just previous to or about the time of sun-spot maxima.‖ Further, these polar prominences are responsible for the existence of large coronal streamers near the solar poles, as seen during solar eclipses about the time of sun-spot maximum. In fact, recent research seems to indicate that this prominence circulation is intimately associated with all the different forms of the corona.*

* 'Klimaschwankungen,' Eduard Brückner (Vienna, 1890).

† *Proc. Roy. Soc.*, Vol. 68, pp. 285–300.

‡ 'Memorie della Societa degli Spettroscopisti Italiani.'

§ *Proc. Roy. Soc.*, Vol. 71, pp. 446–452.

‖ *Ibid.*, pp. 244–250.

There seems little doubt, therefore, that we must look to the study of the solar prominences not only as the primary factors in the magnetic and atmospheric changes in our sun, but as the instigators of the terrestrial variations.

In dealing with solar phenomena, especially from a meteorological point of view, it is of great importance that the solar disc be treated in zones and not as a whole.

Just as it has been shown that the prominences sometimes exist in these zones in one hemisphere at one time, so is this the case with spots, but unfortunately, it is only until very recently that the phenomena occurring in each hemisphere have been treated in this manner.

It has already been pointed out that a possible connection existed between changes in the spotted area of the sun and terrestrial temperatures. Quite recently this question has been studied by Charles Nordmann † who finds that—

> The mean terrestrial temperature exhibits a period sensibly equal to that of solar spots; the effect of spots is to diminish the mean terrestrial temperature, that is to say, that the curve which represents the variations of this is parallel to the inverse curve of the frequency of solar spots.

NORMAN LOCKYER.

SOLAR PHYSICS OBSERVATORY,
SOUTH KENSINGTON.

THE GERMAN ANTHROPOLOGICAL ASSOCIATION.

THE German Anthropological Association is just as old as the German Empire. The thirty-fourth meeting of the society, held at Worms, August 9–13, 1903, was the first to take place since the death of its most distinguished founder, the late Ru-

* *Monthly Notices R. A. S.*, Vol. LXIII., 1903.

† *Comptes Rendus*, No. 18, May 4, 1903, Vol. 136.

dolph Virchow. Professor Virchow is said not to have missed a meeting of the association since its organization until disabled by the accident which eventually ended in his death. The tribute paid to him in Professor W. Waldeyer's presidential address was, therefore, eminently fitting. Virchow helped to do for anthropology in Germany thirty-three years ago what was done for anthropology in America only last year by the founders of the American Anthropological Association. He was a potent factor in the growth of the science, as well as of the new organization, and that of both was phenomenal. Three hundred and forty-five took part in the Worms meeting. A study of the program and of the audiences at every sitting was, to me, a source of inspiration, and strengthened my faith in the future of our own association, now scarcely more than a year old. But Professor Waldeyer's address was not all tribute. He called attention to the needs of an international understanding as to methods in anthropometry, of more thorough and general university instruction in anthropology; a closer union of the various anthropological organizations of each nation, and, for Germany especially, a great central anthropological institute for purposes of both research and instruction. Berlin was suggested as a suitable location for such an institute, on account of its large and varied collections. It was also suggested that municipal and provincial museums turn over to the central institute all needed duplicates and whatever else could be spared. This is precisely what is being done in Denmark, which has gone even further and made the director of her National Museum supervisor of all the provincial museums. The director pays an annual visit to each museum. If he finds specimens that are needed toward making the national collection more complete, the smaller museum must, for a consideration, part with these, even though they be not in the nature of duplicates.

Professor Schwalbe's paper, the first on the program, was somatological: 'On a Comprehensive Investigation of the Somatic Characters of the German People.' The speaker passed in review what had been done already in this direction. All are familiar with the collection of statistics relative to the color of the skin, hair and eyes of 6,758,827 German school children. These results, due largely to Ecker and Virchow, were published in 1886. Schaaffhausen's extensive catalogue of the collections of crania in the German museums aided materially in determining the distribution of head-form in the empire. Schwalbe hopes to see done for Germany what has been done for France by Collignon and Lapouge; for Italy, by Livi; and for Sweden, by Fürst and Retzius. More has been accomplished for Spain than for Germany; and even less is known about Great Britain, Denmark, Holland and Belgium. As regards the German Empire, exception must be made of Baden and Bavaria, thanks to the labors of Ammon and Ranke, respectively.

Observations on school children alone will not suffice, and in Prussia, especially, permission to make the necessary observations on soldiers has not yet been obtained from the Ministry of War. For fifteen years Professor Schwalbe has made use of material furnished by the anatomical and pathological institutes in Strassburg. In that time he has measured 4,000 Alsatians, 1,500 of which, including both sexes, were adults. Professor Schwalbe's paper was accompanied by a table designed for use in taking measurements on corpses. The interest in his paper found immediate expression in the appointment of a commission.

Professor Rudolph Martin presented 'Some New Anthropometric Instruments,'

intended both for the laboratory and for field-work. Professor Ranke discussed 'Brain Measurements and the Horizontal Plane of the Brain'; and Dr. Birkner, 'Race Anatomy of the Soft Parts of the Face.' The latter had prepared instructive tables showing the differences between the facial type of the Chinese and that of the European. The 'Comparative Osteology of the Human Forearm,' by Dr. Fischer, was a comparison of the upper portion of the ulna in man and anthropoids, with special reference to the Neanderthal race. Drawings and tables were used in illustration. Dr. Gaup's 'The Vertebrate Skull with Demonstrations from Models,' a phylogenetic study, was especially appreciated by the anatomists present.

Dr. Tschepourkowsky, secretary of the Russian Anthropological Society, was present and read a paper: 'On the Inheritance of the Cephalic Index from the Side of the Mother.' Professor Stieda presented: 'Painted Human Bones from Southern Russia.' The coloring matter was probably applied originally to the bodies at the time of burial, and received indirectly by the bones after the flesh had disappeared. Dr. K. von den Steinen spoke of "Genealogical 'Knotenschnüre' in the South Seas." This ancient and unique mnemotechnic system is still retained by the natives, and serves them as writing and as genealogical charts.

Dr. Thilenius's paper dealt with the art of a people now practically exterminated: 'Ornamental Carvings from Agomes' (Bismarck Archipelago). An interesting collection of wood carvings, especially spatulæ employed in the betel habit, has fortunately been preserved. The series includes all gradations between the human form and various animal forms.

Of kindred interest was 'The Significance of Mat- and Tattoo-patterns among the Marshall Islanders,' by A. Krämer. These unique and beautiful patterns are successfully combined with color schemes. Tattooing is looked upon as a gift of the gods and its execution is combined with religious ceremonies. Other ethnographic themes were: 'The Value of Ethnographic Analogies,' by Dr. Ehrenreich; 'South American Weaving and Basketry,' by Dr. Max Schmidt; 'The Problems of Social Ethnology,' by Dr. Steinmetz, and 'Ethnographic Transformations in Turkestan,' by R. Karutz, who referred to the changes that have taken place with the Russification of West Turkestan.

Professor Seger was heard on a subject in which he is *facile princeps:* 'The Ruins of Yukatan.' In his paper on 'The Protection of Prehistoric Monuments,' Dr. Seger recommends: (1) The passage of a protective law; (2) the appointment of a commission for each province; (3) the creation of a special fund to be used for the purpose of purchasing monuments or sites, of carrying on research and of publishing reports; (4) the fixing of geographic boundaries within which central, provincial and local museums are to find their respective spheres of influence and activity; (5) the adoption of a uniform procedure in respect to excavations, and the general treatment of specimens. The association inaugurated the movement in line with Dr. Seger's suggestions by appointing an archeological commission.

Dr. Edmund Blind's paper, entitled 'Neolithic Inhabitants of Alsace,' fills a gap in the anthropological history of that region. According to his researches, the Neolithic race in Alsace was dolichocephalic. Not a single brachycephalic skull was found, although some were on the borderland of mesocephaly. A similar topic, 'The Races of the Stone Age,' by L. Wilser, led to a lively discussion.

Dr. Lissauer's "Scheme of Classification

for 'Radnadeln'" had already appeared in print. Dr. Schumacher's subject was: 'On Bronze Age Caches in Southwestern Germany.' For convenience or safety these caches were so located as easily to be found by the owner; often near some prominent natural feature, as a cliff or rock. They were sometimes placed in large pots or wooden chests, or wrapped in skins. Such stores include weapons, tools and ornaments of bronze; gold ornaments are rare. They make it possible to trace definite prehistoric trade routes. It has been determined, for example, that the source of supply during the early bronze age was the Danube valley, while later the imports were from northern Italy, Switzerland and France. Ancient roadways as well as mountain passes have been traced.

Dr. C. Mehlis discussed 'Burial Tumuli of the Pre-Roman Period in the Vorderpfalz,' including those of the late bronze age, Hallstatt and La Tène epochs; and Herr Welter, 'The So-called Mardellen of Lorraine,' dwelling sites belonging to the La Tène epoch. Professor H. Klaatsch's contribution, 'The Problem of the most Primitive Flint Artifacts,' aroused unusual interest. By way of demonstration, several hundred primitive implements from France, England, Belgium and Germany were displayed so as to form a geographic, as well as chronometric, series, as follows: (1) Puy Courny and Puy Boudieu, Aurillac (upper Miocene); (2) Chalk Plateau, Kent and Sussex (middle Pliocene); (3) Saint-Prest, France (upper Pliocene); (4) Britz and Rüdersdorf, Berlin; (5) Taubach; (6) Belgian Diluvium; (7) Eoliths from Chelles; (8) Vézère (Paleolithic). Professor Klaatsch had personally visited all the localities named, and had himself collected most of the specimens exhibited. He agrees with the views expressed by Rutot of Brussels, the ablest living exponent of the so-called eoliths of the Tertiary and Quaternary epochs. Many of the pieces, although not intentionally shaped, had evidently been utilized; others again were slightly altered so as to accommodate the hand, and still others showed definite series of retouches.

Dr. J. Nuesch gave the results of 'Recent Archeological Discoveries at Kesslerloch.' This important station has been known since 1874, when the north entrance was excavated. Very important discoveries have recently been made in the south entrance. These discoveries make it clear that Kesslerloch is older than Schweizersbild, another well-known station in which important finds have recently been made. From the view point of paleolithic art. Kesslerloch also stands preeminent among Swiss stations.

Nuesch has not only collected over 2,000 specimens of the paleolithic period, including wonderful pieces of sculpture and engraving, but also hearths with burnt bones of the mammoth, rhinoceros, reindeer and wild horse. Dr. Nuesch announced the further discovery of remains of a pygmy race at Kesslerloch. Those who attend the International Congress of Americanists to be held in Stuttgart next summer will have the opportunity of visiting both Kesslerloch and Schweizersbild as a part of the official program.

Worms has long been recognized as one of the chief historic cities of Germany, as well as the center of the Teutonic legendary period. Recent discoveries in the environs serve to place her in the forefront from the view point of the prehistoric also. To the researches of Dr. Koehl, chairman of the local committee, Worms is indebted for this new and proud distinction. His excavations cover a period of several years, and have to do with not only the burial places dating from various epochs of the neolithic period, but also with those of the Hallstatt, Roman and Frankish epochs. In anticipa-

tion of the meeting, he had uncovered just outside the city thirty or forty Roman and Frankish burials, as well as the remains of an ancient Roman roadway. The skeletons and funerary objects were left in their original positions until after our visit, when they were removed—the skeletons to the Berlin Museum, and all other objects to the Paulus Museum in Worms. Excavations of a similar nature had also been carried on under Dr. Koehl's direction at three other localities. Near the West-end School in Worms, we were permitted to see burials of the Hallstatt epoch; while at Monsheim and Mölsheim, a few miles to the west of Worms, neolithic burials and dwelling sites, belonging to three different epochs, were exposed to our view. Here the pottery belongs to three distinct types, as set forth in Dr. Koehl's 'Festschrift' ('Die Bandkeramik der steinzeitlichen Gräberfelder und Wohnplätze in der Umgebungen von Worms'), as follows: (1) An early geometric pottery, the so-called Hinklestein type; (2) the Spiral-meander type, and (3) a later geometric pottery or Rössener type.

The next meeting of the association will be held in Greifswald, and is to include on its program an excursion to the museums of Stockholm.

George Grant MacCurdy.

Yale University Museum,
October 28, 1903.

SCIENTIFIC BOOKS.

SMALL'S FLORA OF THE SOUTHEASTERN UNITED STATES.

Two works, each of them a masterpiece in its time, have given us our principal knowledge of the plants of the Southern United States. The first, 'Elliott's Sketch of the Botany of South Carolina and Georgia,' appeared in 1821 to 1824. The second, 'Chapman's Flora of the Southern States,' was first published in 1860, and was issued also in subsequent editions with new matter in the form of appendices. All botanists will welcome Dr. John K. Small's 'Flora of the Southeastern United States,' the new masterpiece of southern botany. The book contains 1,370 pages, besides twelve pages of introductory matter, and describes 6,364 species—another illustration of the fact that we are living in a time of men who do things. It is interesting to note in this connection that the author, after giving us in these 1,382 pages the result of ten years' persistent labor, required only a modest twenty-five lines of preface to tell how he did it. The work will be especially useful to botanists in Mississippi, Louisiana, Texas and Oklahoma because those districts have been only imperfectly covered by the preceding floras, which were based chiefly on material from the South Atlantic states. The new work does not, it is true, profess to contain more than the plants east of the one hundredth meridian, but in fact we do find in it such distinctly desert types as the ocotillo, *Fouquieria splendens,* and the creosote bush, *Covillea tridentata.*

The book follows the Engler and Prantl sequence, the American Association nomenclature and the metric system of measurement. It also gives family names throughout a termination in -aceae, a practise which has already been adopted in the publications from the United States National Herbarium and which, it is believed, will meet with general approval. The name Brassicaceae, for example, is a much more orderly, suitable and significant designation for the mustard family than the name Cruciferae, and it is only the greater familiarity with the latter name which leads many botanists still to cling to it.

It has come to be generally recognized in the last two decades that the generic grouping of species would be much more convenient and significant if the looser genera, containing diverse groups of species, which had been fashionable during the preceding half century, were divided into genera each of which represented an evident genetic community. A subdivision of these loose genera has been going on for several years past in America and in Germany. In Dr. Small's new book this tendency has been carried to an extreme to

which not all of us will be prepared to follow. Most botanists will approve the generic separation of the deerberries, represented by *Vaccinium stamineum,* from the blueberries, represented by the European *Vaccinium myrtillus* and its several American relatives, and many will prefer to join him in separating *Vaccinium erythrocarpon* as a generic type under the name *Hugeria,* but it is doubtful whether many will be willing to place the white pine in the genus *Strobus,* distinct from *Pinus,* or the nut pine of Arizona in still another genus, *Caryopitys.*

The book is not wholly without evidence of ill-considered conclusions, as may be illustrated by the genus *Ribes.* Pursh in 1814 described from the garden of Fraser, the English nurseryman, a *Ribes resinosum* which was alleged to have come from the mountains of eastern North America. The plant afterward was identified by several competent botanists with *Ribes orientale,* from the mountains of Asia Minor, and was accordingly dropped from the American flora. If the author has sufficient evidence to restore the plant to good standing as a native of the Southern United States, he does not adduce it in his book. The name *Ribes gracile* Michx. has been transferred from the plant with which it has been associated for a generation and applied to a plant to which on geographic grounds it could not possibly have applied, while for the plant we formerly knew as *gracilis* Nuttall's name *missouriense* has been taken up. It is more than doubtful whether changes based on such imperfect or incorrect information are advisable.

Most botanists will be slow in becoming convinced that the southern states contain 53 species of *Sisyrinchium* or 185 species of *Crataegus,* but it must be stated that the matter in both these genera was prepared by special contributors, not by Dr. Small himself.

The admirable keys with which the book is equipped throughout, a new feature in Southern floras, will greatly facilitate its use by students. This and the other timely and authoritative qualities of the work so greatly counterbalance any faults that may be charged against it that the book will necessarily take its place as the standard work on Southern botany.

Frederick V. Coville.

Ueber die Bedeutung des Darwin'schen Selectionsprincips und Probleme der Artbildung. By Dr. Ludwig Plate. Second edition. Leipzig, W. Engelmann. 1903. 8vo. Pp. viii + 247.

The mass of literature which has grown up around the doctrine of natural selection since it was first propounded has reached the proportions of a forest, so dense that one may well shrink from the task of penetrating its depths or of keeping pace with its rapid growth. Numerous sturdy trees, well repaying a close acquaintance, occur, but they are apt to be hidden from view by the peculiarly dense and luxuriant undergrowth which characterizes the forest.

The importance of the subject is too great, however, to permit its neglect merely on account of difficulties in the way, and the student of the theory of descent will be grateful to Dr. Ludwig Plate for a careful and critical review of the literature bearing on the theory of natural selection, which has appeared during the last twenty years.

Dr. Plate's essay was first published some four years ago in the 'Verhandlungen der deutschen Zoologischen Gesellschaft' and is now republished in a somewhat enlarged form under the title given above. It is a concise yet clear exposition of the arguments that have been advanced in opposition to the theory of natural selection and of the principles which have been suggested as accessories in the transmutation of species, and with the exposition there goes keen criticism backed by a wealth of illustration, in itself of the greatest interest and evidencing in the author unusual powers of observation and aptness in application. A further chapter deals with the postulates of the doctrine of natural selection, such as an excessive birth rate, variability and isolation, and a concluding one considers the significance and limitations of the Darwinian and Lamarckian factors, especially with regard to adaptation.

That the work is of merit is abundantly shown by its appearance in a second edition

so soon after its original publication, both as a separate volume and as a contribution to the proceedings of a learned society. It is not merely an exposition of conflicting views; it is a decided contribution to the theory of descent, a perusal of which is rendered both interesting and in a high degree instructive by a notable clearness of statement and a judicious and intelligent arrangement of topics. Every student of the theory of descent will find it of great value, and an English translation, which might render it available for the wide circle of those interested in the present position of the theory of natural selection, is highly desirable.

It may with propriety be added that the book is furnished with an excellent author and subject index and contains a bibliography consisting of over two hundred and sixty references.

J. P. McM.

SCIENTIFIC JOURNALS AND ARTICLES.

THE longer articles of the September and October numbers of the *Botanical Gazette* are all ecological. They contain the first half of a long contribution to the ecological plant geography of the province of New Brunswick by Professor W. F. Ganong, of Smith College, entitled 'The Vegetation of the Bay of Fundy Salt and Diked Marshes.' The first instalment discusses the distribution and extent of the marshes (with maps); their geological origin and mode of formation; the economics of the marshes, including crops, prices and mode of reclamation; factors determining the ecological features of the marsh vegetation, including a discussion of the relations of water, temperature, light, soil and animals; and after summarizing the ecological factors the author enters upon a consideration of the vegetation of the marshland.—Mr. G. H. Shull, of the University of Chicago, gives a thorough account of 'The geographic distribution of *Isoetes saccharata*,' a plant limited to the fresh-water portions of Chesapeake Bay and its tributaries. After listing and mapping the known stations of this plant, the author discusses the causes to which its restricted distribution is due. He considers it autochthonous in Chesapeake Bay and the parent of *Isoetes riparia*, its present distribution being explained by the geomorphic movements of the coastal plain.—Mr. S. B. Parish, of San Bernardino, presents 'A Sketch of the Flora of Southern California.' After an extended statement of the orographical features of the region, the deserts, the drainage system, the geological formations and the climate, he describes the phytogeographic areas and discusses the flora peculiar to each. The interrelations of the different life areas, the physiognomic characteristics of the flora, the distribution of the plants, the statistics of classification and the affinities of the flora are successively presented. The paper closes with a comparison of the flora of southern California with that of various other regions east and west, and with a few words on the cryptogamic flora, which has yet been imperfectly explored.—In the October number Professor John W. Harshberger, of the University of Pennsylvania, presents the first part of 'An Ecological Study of the Flora of Mountainous North Carolina.' The topography, drainage, physiography and geology of the region are described, and also the effect of the physiographic changes upon the distribution of plants. After discussing the phenological distribution of plants the author takes up the influence of glaciers upon the flora of North Carolina and the principles underlying the distribution of plants in eastern America, closing this portion with a consideration of the effect of edaphic factors.—The 'Briefer Articles' are more varied. In the September number Professor Charles Thom describes a gall produced by insect larvæ upon a delicate mushroom, *Omphalia campanella*, a phenomenon which has not been previously reported.—Professor W. C. Coker, of the University of North Carolina, shows that the usual absence of dorsal air chambers in the genus *Dumortiera* is dependent upon its semi-aquatic habits, and that it has evidently been derived from forms possessing such structures. He also gives a drawing showing the origin of the branched cells ramifying in the Nostoc-chambers of *Blasia pusilla*. In the sporangium of *Sphærocarpus terrestris* he finds round sterile cells, probably the homo-

logues of elaters, containing chlorophyll bodies which remain green almost to the time of ripening of the spore. In the October number Professors G. F. Atkinson, of Cornell University, and W. C. Coker, of the University of North Carolina, describe a minute new species of *Geaster, G. leptospermus,* belonging to the fornicate section of the genus, which was found growing upon mosses on tree trunks by Professor Coker.—Professor B. M. Davis, of the University of Chicago, notes the occurrence of spores of a *Tilletia* (?) in the capsule of *Ricciocarpus natans,* and Dr. Florence M. Lyon figures a section of the sporophyll and axis of *Selaginella rupestris,* showing two megasporangia, a phenomenon not hitherto reported.—There are the usual reviews of current literature and items of news.

SOCIETIES AND ACADEMIES.

THE TORREY BOTANICAL CLUB.

At a meeting of the club held at the College of Pharmacy on October 15, 1903, Dr. Rusby occupied the chair.

The scientific program consisted of brief informal reports on the summer's work by the different members.

Dr. Britton reported having made a second trip to Cuba, leaving New York the latter part of August. He was accompanied by Mrs. Britton and Mr. Percy Wilson. In part the same ground was covered as in his first expedition, but the journey was continued into the province of Santa Clara. At Sagua a small area was encountered covered by an isolated flora somewhat similar to that found at Madruga on the first trip. Both areas were characterized by an abundance of a peculiar palm that was not seen elsewhere. The species is as yet undetermined, but living specimens have been successfully brought to the garden. Both of these peculiar plant associations are on soil areas quite different from the prevailing coral-limestone formation.

Mr. Earle reported having made a trip to Porto Rico in the interest of the Department of Agriculture during the last of May and the first of June. The trip was mostly for the purpose of noting the diseases of economic plants, and a report has been submitted to the department. One of the most interesting things observed was the occurrence of several fungous diseases of scale insects. Two of these diseases were abundant enough to constitute efficient checks on the scales attacked.

Professor Lloyd reported having spent some weeks on the island of Dominica, accompanied by Mrs. Lloyd. He observed many orchards of limes in poor condition owing to the attacks of scale insects and wood-destroying fungi. He illustrated his exploration of the island by means of a blackboard map showing the position of three volcanic craters and of the highest peak visited, 4,700 feet. A large collection of herbarium material was secured.

Professor Underwood spoke on the ferns of Jamaica. He left New York early in January, spending five months in Jamaica and eastern Cuba. Jamaica is especially rich in ferns, about five hundred species being known from the island. Of these he collected over four hundred, mostly in the Blue Mountain region from an area about equal to that of Westchester County. A hundred species may be taken along the bridle path from Cinchona to Morce's Gap, a distance of three miles. Tree ferns become abundant at an elevation of about 3,000 feet. Thirty species are more or less common. The trunks are often covered by rich growths of filmy ferns, of which about sixty species occur. The John Crow Mountains in eastern Jamaica have never been visited by botanists and the 'Cock Pit Country' in the western end of the island had not been previously visited. He spent a week, accompanied by Mr. Harris, of Hope Gardens, Jamaica, in exploring one corner of this region and found many things of interest.

Mr. Nash reported on his recent trip to Haiti. The country belongs to the negroes and a white man has to take second place. The island is 407 miles long by 195 miles wide, with extremely diversified topography. There are two main ranges of mountains. Large salt lakes occur in the southern portion. In the north-central area there are large pine forests. The strand flora is much like that of the other islands, but as you get into the interior the character entirely changes and there are

many endemic species. Tree ferns begin at 1,500 feet elevation, but they are much more abundant at 3,500 feet, the highest point reached by the expedition. There are no roads in the interior, only uncared for bridle trails, and there are absolutely no bridges. One stream was forded sixteen times in a distance of twelve miles. A thousand numbers of herbarium material were secured besides living plants and wood specimens.

Dr. Howe spoke of two months spent in Porto Rico collecting marine algæ. He found the species fairly numerous, but on the whole the marine vegetation was less striking and luxuriant than on some of the Florida keys. He visited the north, west and south sides of the island, but found less difference in their algal flora than he had expected. Nine hundred numbers were taken, but so far most of the material is unstudied.

Dr. Murrill reported on his visits to various European herbaria for the purpose of studying types of the species of the Polyporaceæ. Upsala, Berlin, Kew and Paris were visited and some time was spent in field work with Bresadola in the mountains of the Tyrol. Interesting comments were made on the different herbaria and the men who made or are now working with them.

Professor Underwood called attention to the fact that the different expeditions from the botanical garden during the past year had brought back fully 10,000 numbers of herbarium material from the West Indies.

Dr. Britton spoke of the recent death, after a long and painful illness, of Mr. Cornelius Van Brunt, who was one of the oldest members of the club. His work in the photographing of plants was unique, and he leaves a collection of over 10,000 studies on glass. He had done much in devising special lenses and appliances for this special work and his knowledge of photographic technique was remarkable. His earlier studies were with the diatoms, but failing eyesight prevented his work with the microscope and he turned to photography instead. Data are being gathered for a more extended notice of his life.

F. S. EARLE,
Secretary.

NEW YORK ACADEMY OF SCIENCES.
SECTION OF GEOLOGY AND MINERALOGY.

THE Section met in the large lecture hall of the American Museum of Natural History on Monday evening, October 19. Three hundred and fifty-two members and friends were present. The following papers had been presented by Dr. George F. Kunz for reading by title:

Bismuth (Native) and Bismite from San Bernardino County, Calif.

Californite (Vesuvianite), a New Ornamental Stones from Siskiyou County, Calif.

The meeting was devoted mainly to a paper by Dr. E. O. Hovey entitled 'Observations on the 1902–1903 Eruptions of Mt. Pelé, Martinique.' In this paper or lecture the author sketched the principal events in the volcanic history of the island during the past year and a half. He described the phenomena of the eruptions, the mud-torrents and mud-flows, the attendant and subsequent aqueous erosion on the slopes of the mountain, the rise and vicissitudes of the new cone of eruption and its wonderful spine or obelisk. The lecture was illustrated with about ninety-five lantern slides from negatives taken by the author on the two expeditions which he has made to Martinique for the American Museum of Natural History since the eruptions began.

EDMUND OTIS HOVEY,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ANTEDATED PUBLICATIONS.

DURING recent years attention has been called so strongly to the evil of antedated papers published by museums and scientific societies that in general great care has been taken of late to have all brochures emanating from such sources bear the correct date of issue. It is hence all the more surprising to find one American institution of high standing still apparently careless or indifferent in the matter. We believe, however, that the impropriety about to be mentioned is due to either inadvertence or lack of appreciation of

its seriousness on the part of the responsible authorities.

During the last few months the Field Columbian Museum of Chicago has issued a number of papers, some of them describing new species and new genera, which bear date 'June, 1903,' but which were not issued till late in August or early in September. In some instances the authors' separata were not delivered to them till August 20. In one case at least there is internal evidence to show that the paper, dated 'June 1, 1903,' could not have been even printed till some time in July, since reference is made by the author to the July, 1903, number of the *American Journal of Science,* which was not published till July 1 or 2.

I am authoritatively informed that the authors are in no way responsible for the dates, or anything else, on the title pages of these brochures, and hence the responsibility for the antedating of papers which contain descriptions of new genera and species by from eight to ten weeks rests higher up. Presumably it is sufficient to call attention to the matter to have the fault promptly remedied.

J. A. Allen.

THE 27-DAY PERIOD IN AURORAS AND ITS CONNECTION WITH SUNSPOTS.

To the Editor of Science: During the last few months in New England there has been an interesting example of the tendency of auroras to return after intervals of 27 days. The report of the New England 'Climate and Crop Service' shows that auroras were observed in New England on July 25 and 27, the 26th being rainy. Twenty-seven days later auroras were observed on August 21 and 22. The next return of the twenty-seven-day period was September 17 to 19. General rain fell on September 17, but auroras were observed on the 18th and 19th. Twenty-seven days later was October 14 to 16. Auroras were observed on the 13th and possibly on subsequent dates (the reports are not yet in).

Another group of auroras began on August 26, was observed again on September 21 and was due on October 19.

Each of these auroral displays was connected with sunspot activity and may have preceded the first appearance of the spot. A fine group of sunspots crossed the surface of the sun next the earth on October 5 to 17, passing the sun's meridian about October 13. A second smaller isolated spot crossed the sun's meridian on October 18 or 19.

About November 1 a very large sunspot crossed the meridian of the sun next the earth and with it apparently began a new series of auroras which were very brilliant on the early morning of November 1 and again on the evening of the same day.

According to the theory of Arrhenius, which has much to sustain it, auroras are caused by small highly electrified particles of matter carried outward from the sun by the pressure of light when the sun is in a high state of activity. These particles are intercepted by the earth's atmosphere and from them is derived the electrical charge which gives rise to auroras and magnetic currents ('Lehrbuch der kosmischen Physik,' page 920).

The twenty-seven-day period in the aurora arises from the fact that it takes twenty-seven days for a center of disturbance on the sun to rotate around and face the earth in the same relative position again. The period is not a permanent one, the disturbance at any given point lasting usually only for a few solar rotations, and is then displaced by a disturbance at some other part of the sun with which another series of auroras is connected.

There is, however, a twenty-seven-day period of auroras connected with the siderial revolution of the moon. This, however, is of minor importance and can only be detected by a long series of averages (*American Journal of Science,* Vol. V., 1898, p. 81).

If the auroras described here were of solar origin they were probably visible over a large part of the northern and southern hemispheres. Some of them were very brilliant. The aurora of August 21 was described in the *Popular Science Monthly,* Vol. LXIII., pp. 563–564, by A. F. A. King, and in Vol. LXIV., pp. 87 and 88, by Alexander Graham Bell.

Henry Helm Clayton.

SHORTER ARTICLES.

MONT PELÉ FROM MAY TO OCTOBER, 1903.

THE changes which have taken place in the new cone of Mont Pelé within the last few months have been very considerable, and are worthy of record. The wonderful growth of the spine upon the top of the cone has been fully described by Professors Lacroix, Heilprin and Sapper and the author. The author's article in the *American Journal of Science* for October brought the detailed history of the cone down to the month of April last. There was at that time a tremendous spine or tooth more than 1,000 feet in height, rising from the side of a cone-shaped base, the top of which was higher than the old altitude of Morne Lacroix. The tip of the spine was about 600 feet above the highest part of the new cone. Since the first of May there have been considerable variations in the activity of the volcano and in the form and altitude of the cone and spine. It is the purpose of the present note to give the readers of SCIENCE a condensed statement of the facts as they have been observed by the French commissioners during the past six months and reported by Professor Giraud and Captain Perney in the *Journal Officiel de la Martinique* published at Fort de France.

During the month of May the apex of the spine rose slowly until the thirtieth, when there occurred a loss of about fifty meters. Considerable incandescence was observed at night, when the condition of the clouds permitted observations to be made, and there were several eruptions of steam to an altitude of from 3,000 to 4,500 meters. Most of the dust clouds thrown out by the mountain pursued the familiar course down the valley of the Rivière Blanche. There was marked increase in the energy of action during the last week of the month, which diminished, however, during the first week of June. During June the spine rose again with varying degrees of rapidity, until it seems to have regained much of the altitude lost at the end of May. Minor eruptions were numerous during the month, and the dust-flows, of 'Nuages Denses' of Lacroix, rushed with violence and great velocity down the valley of the Prêcheur, as well as that of the Rivière Blanche. The latter fact is of interest in connection with observations made in February and March, that the northwestern side of the new cone had become continuous in slope with the exterior of the old cone of the mountain.* The V-shaped gash in the old crater has long ceased to be the sole exit for the flows of dust-laden steam, or the principal factor in guiding their course. The records show that the western side of the spine kept losing material constantly, so that late in June and early in July it was even more pointed and blade-like than in March. Between July 5 and 7, however, there was a loss of altitude amounting to fifty meters, and another fifty meters was lost in the succeeding week. On the 18th it was observed that eighteen meters more had disappeared. This diminution continued into August, a measured loss amounting to twenty-five meters having occurred by August 6.

On August 17 Professor Giraud saw the mountain free from clouds for the first time in several days, and perceived that the *dome* of the cone surmounting the crater had undergone profound modification, the central portion having risen twenty-seven meters within ten days. Reddish-brown clouds frequently appeared in the midst of the blue and white vapors which were continually rising from the crater. During the night the dome sometimes showed itself incandescent; some of the luminous points persisted throughout the whole night, and there were frequent discharges of incandescent blocks. The increase of activity continued in marked degree for several days, and the main mass of the dome, as distinguished from the spine, continued to rise. There were numerous dust-flows down the valley of the Prêcheur and of the Blanche, and on the 22d, in the direction of the Lac des Palmistes and Grand' Rivière as well. Night after night the top and slopes of the new cone or dome were incandescent, and often sufficiently so to cast a strong illumination upon the clouds. Fumaroles were active in the valley of the Sèche, as well as in the valley of the Blanche. The growth of the great dome continued rapid, one hundred and

* *Am. Jour. Sci.*, Vol. XVI., p. 277, October, 1903.

four meters being the measured increase from August 21 to 31. The eruption of September 2 caused a loss of thirty meters, and the succeeding five days saw thirteen meters of this regained; a gain, however, which was only temporary, fifteen meters being lost upon the following day. During the remainder of the month there was an irregular increase of thirty-one meters, with a loss between the 15th and 18th of five meters. The total increase in height of the dome for the six weeks ending the first of October was about one hundred and twenty-seven meters.

The great spine which was such a wonderful part of the mountain from November, 1902, to June, 1903, had practically disappeared early in August when the main mass of the cone, or the 'dome' as it may well be called, began to rise so rapidly. The first spine rose from the northeastern quarter of the new cone. On September 8, after four days in constant cloud, the summit appeared and it was seen that the dome culminated in a sharp tooth or spine rising from its northwestern portion. Within a week this new spine was pushed up twenty meters, but an eruption on September 17 destroyed it. At the end of the month (September) the highest part of the dome was at the south.

During about six weeks in August and September the activity of the volcano was so great as to cause serious fears of the recurrence of great eruptions, and several warnings were sent out by the geological commission to the inhabitants of the northern and northeastern parts of the island of Martinique. On September 12, at 2 P.M., there was an eruption, the dust cloud of which covered the Lac des Palmistes and rapidly descended the eastern slopes of the mountain toward the village of Morne Balai to the altitude of about seven hundred meters; that is to say, it reached the limit of the zone devastated by the eruptions of May, 1902. A week later three such clouds followed one another in quick succession nearly to the same extent. On September 16 an eruption cloud rose vertically to the extraordinary altitude of 7,000 meters. During the latter part of September, however, the activity diminished again, and is recorded as being very feeble on September 30. The bulletins from October 1 to 19, the date of the latest received, indicate only feeble activity of the volcano, with occasional persistent luminosity of the dome. The seismographs which were installed in the observatory at Morne des Cadets in the fall of 1902 had recorded no earth tremor by April 1. Light earthquake shocks made their imprint on these instruments on July 23 and August 28, and others have been noted by the observers at Assier.

Edmund Otis Hovey.

American Museum of Natural History,
November 3, 1903.

THE HUXLEY MEMORIAL LECTURE.*

The fourth annual Huxley memorial lecture of the Anthropological Institute was delivered in the lecture theater of Burlington House by Professor Karl Pearson, F.R.S. The president of the institute, Mr. H. Balfour, occupied the chair.

The lecturer's subject was 'The Inheritance in Man of Moral and Mental Characters,' a subject to which he has devoted many years of close and constant study, and the importance of which, as he observed, from a national point of view can hardly be exaggerated. It was a question of vital importance, he observed, as to how far mental and moral characters were inherited as compared with physical characters. Few denied the inheritance of physique in man, as in animals, but few too applied the results of such acceptance to their own conduct in life. We were agreed that good homes and good schools were essential to national prosperity, but were apt to overlook the possibility that the home standard was itself a product of parental stock, and that the relative gain from education depended to a surprising degree on the raw material. Since the publication of Francis Galton's epoch-making books it was impossible to deny *in toto* the inheritance of mental characters. But it was necessary to go a stage further and ask for an exact quantitative measure of the inheritance of such characters and a comparison of such measure with its value for the physical characters. Accordingly he had some six or seven years ago set

* From the London *Times*.

himself that problem, which really resolved itself into three separate investigations—namely, a sufficiently wide inquiry into the actual values of inheritance of the physical characters in man, and this was carried out by the measurement of upwards of 1,000 families; a comparison of the inheritance of the physical characters in man with that of the physical characters in other forms of life; and an inquiry into the inheritance of the mental and moral characters in man. In respect of this last set of investigations children were taken in schools of different sorts all over the country, and the opinions of teachers were asked upon the characters of their pupils in respect of the physical, mental and moral resemblances between brother and brother, sister and sister, and brother and sister. Six thousand circulars were thus sent out to about 200 schools. In respect of physical characters the data included the cephalic index—*i. e.*, ratio of the length to the breadth of the head, the span, color of eye and hair, curliness of hair, athletic power and health. In respect of all these the measure of the fraternal resemblance, indicated by the well-known regression line, was as two to one—that is to say, that if one of the pair exceeded the mean by a certain amount, the other of the pair tended to exceed the mean by half that amount; and similarly in respect of defect from the mean. This was always true for all the physical characters yet worked out in man. Now, seeing there was this surprising uniformity in the inheritance of the measurable physical characters, could these results be extended to psychical characters? Could we—that was the whole problem—get a corresponding regression line of two to one in steepness or slope in respect of mental and moral characters. A very large number of observations made on 1,918 pairs of brothers as to vivacity, assertiveness, introspection, popularity, conscientiousness, temper, probity, handwriting and general ability showed that while the line of regression was one to two or 50 to 100 in respect of physical characters, the smaller number was represented in respect of mental and moral characters by 51; while in respect of a large number of pairs of sisters it was 52, and these two numbers tended to approximate to 50 with an allowance for probable error. Hence there could be small doubt that intelligence or ability followed precisely the same laws of inheritance as general health, and both followed the same laws as cephalic index or any other physical character. There was a true line of regression in each case (.5 or 1 to 2), and it could safely be said that general health in the community was inherited in precisely the same manner as head-measurements or body-lengths. What results followed therefrom? By assuming our normal distribution for the psychical characters, there was found, in addition to self-consistent results, the same degree of resemblance between physical and psychical characters; and that sameness involved something additional—namely, a like inheritance from parents. We inherited our parents' tempers, conscientiousness, shyness and ability, even as we inherited their stature, forearm and span. Again, within broad lines, physical characters were inherited at the same rate in man and the lower forms of life. The irresistible conclusion was that if man's physical characters were inherited even as those of the horse, the greyhound or the water-flea, what reason was there for demanding a special evolution for man's mental and moral side? If the relation of the psychical characters to the physical characters was established, what was its lesson? Simply that geniality and probity and ability might be fostered by home environment and by provision of good schools and well-equipped institutions for research, but that their origin, like health and muscle, was deeper down than those things. They were bred and not created. It was the stock itself that made its home environment, and the education was of small service unless it were applied to an intelligent race of men. Our traders had declared that we were no match for Germans and Americans. There did seem to be a want of intelligence to-day in the British merchant, workman or professional man. The remedy was not in adopting foreign methods of instruction or in the spread of technical education. The reason of the result was that the mentally better stock in the

nation was not reproducing itself at the same rate as of old; the less able and the less energetic were more fertile than the better stocks. No scheme of wider or more thorough education would bring up in the scale of intelligence hereditary weakness to the level of hereditary strength. The only remedy, if one were possible at all, was to alter the relative fertility of the good and bad stocks in the community. Grave changes had taken place in relative fertility during the last forty years. He ventured to think that we now stood at the beginning of an epoch that would be marked by a great dearth of ability. We had failed to realize that the psychical characters—the backbone of a state in the modern struggle of nations—were not manufactured by home and school and college; they were bred in the bone, and for the last forty years the intellectual classes of the nation, enervated by wealth or by love of pleasure, or by following an erroneous standard of life, had ceased to give us in due proportion the men wanted to carry on the ever-growing work of our empire, to battle in the fore rank of the ever-intensified struggle of nations. The remedy lay first in getting the intellectual section of our nation to realize that intelligence could be aided and be trained, but that no training or education could create it. It must be bred; that was the broad result flowing from the equality in inheritance of the psychical and the physical characters in man, and that result constituted a problem for statecraft to deal with.

SCIENTIFIC NOTES AND NEWS.

President Schurman, of Cornell University, has proposed the erection of a new building for Sibley College, in memory of the late Professor Thurston, to be known as Thurston Hall. The students of Sibley College have voted to erect a bronze memorial tablet in honor of Professor Thurston.

Dr. C. S. Sherrington, professor of physiology at Liverpool University, will give the second series of Silliman lectures at Yale University.

Professor H. S. Jacoby, of Cornell University, is spending the present term in the practical study of the bridges of the chief railroads of the United States and Canada.

Professor J. Culver Hartzell, of the Illinois Wesleyan University, is in Munich, having been given leave of absence for eighteen months. He is studying the upper devonian of Europe. The past seven months he has spent in Germany, and the next five months will be spent in Italy and Switzerland.

We learn from Bulletin No. 4 of the Bureau of Agriculture of the Philippine Islands that Dr. Janet Perkins has been authorized by the Carnegie Institution to work on the Philippine flora at the Botanical Garden in Berlin.

Dr. Llewellys F. Barker, professor of anatomy in the University of Chicago, sailed for Europe on November 7.

Professor E. W. Scripture, of Yale University, is in Munich carrying on researches on the analysis of speech by means of gramophone records, under the auspices of the Carnegie Institution.

Professor H. S. Hele-Shaw, who holds the chair of engineering at Liverpool University, has been appointed, through the Colonial Office, to organize technical education in the Transvaal and the Orange River Colony. The appointment is not a permanent one, and Professor Hele-Shaw has been granted leave of absence by the university council until September next.

The committee of the National Physical Laboratory has appointed Mr. W. A. Caspari to the post of junior assistant in the chemical department.

We learn from *Nature* that Mr. G. Marconi, in company with Captain H. B. Jackson, has gone to Gibraltar to carry out further experiments in wireless telegraphy for the Admiralty. It is hoped to be able to open communication with Gibraltar before losing touch with Portsmouth.

Baron E. Nordenskiold has arranged to make a zoological and anthropological expedition to the frontiers of Peru and Bolivia. The expedition will start from Stockholm at the end of December or the beginning of January.

While students of the Agricultural College

at the Ohio State University were witnessing on November 6 the harvesting of a field of corn for ensilage purposes by a machine operated by an old traction engine, the boiler exploded and pieces of iron were thrown through the crowd of students. The engineer was killed, and Vernon H. Davis, assistant professor of horticulture, was injured.

WE learn from *Nature* that the bust of John Dalton, presented to the Manchester Literary and Philosophical Society by Sir Henry E. Roscoe on the occasion of the centenary of the announcement of the atomic theory, was unveiled on October 20. The secretary read the following letter from Sir Henry Roscoe: "I desire to present to the Literary and Philosophical Society of Manchester a bronze bust of Dr. Dalton, as a memento of the many years of pleasant intercourse which I have in past days spent in converse with its members, and as a recognition of the honor which the society has done me by electing me as an honorary member, and in bestowing upon me its Dalton Medal. The bust is the work of a distinguished sculptress, Miss Levick, and I believe that all those who have seen it agree with me in esteeming it a powerful and lifelike work of art. It will give me great satisfaction to hear that the society accept my gift, and that they value the bust as a work of art and as a reminiscence of the donor." The president, in formally unveiling the bust, observed that it was a happy coincidence that this meeting took place on the anniversary of the date when Dalton communicated to the society his paper on absorption of gases by water, in which was given the first hint of the atomic theory.

DR. FRANK RUSSELL, one of the most promising of the younger American anthropologists, recently of Harvard University, died of tuberculosis in Arizona on November 7.

THE death is announced of Dr. C. T. Hudson, F.R.S., known for his investigations on the rotifers.

AT a meeting of the Kalamazoo Academy of Medicine held on November 3, Dr. F. G. Novy presented the results of work carried on, with the cooperation of Mr. McNeal, in the Hygienic Laboratory of the University of Michigan relative to the cultivation of the trypanosome of Nagana or the Tsetse-fly disease of South Africa. They have succeeded in cultivating this flagellata, *in vitro,* for the past two months (68 days), through six generations. The fresh active cultures reproduce the disease in animals, modified cultures are without virulence and may possibly serve as vaccines. The method of cultivation is the same as that employed for the cultivation of rat trypanosomes, published in the Vaughan *Festschrift.* The rat and Nagana trypanosomes are the first pathogenic protozoa cultivated in pure condition outside of the body.

IT appears that Rear-Admiral R. B. Bradford, chief of the Bureau of Equipment of the Navy Department, in his annual report to Secretary Moody, says that the commission appointed to consider the question of transferring to the Department of Commerce and Labor the hydrographic office, the naval observatory and the nautical almanac office, has reached the conclusion that it would be unwise to transfer these offices from the jurisdiction of the Navy Department on account of their nautical character and their indispensable aid in preparing for war. The bureau says it learns that it is proposed to place these offices under civilian control, and attach them to the secretary's office.

THE new observatory of Amherst College, the corner stone of which was laid on June 23 last, has so far advanced toward completion that the first series of regular observations was begun by Professor Todd and his assistant, Mr. Baker, on October 28. The sum of $100,000 has been raised for endowment, observatory building, protection of the site, instrumental equipment and the director's residence.

As we stated last week, the Academy of Natural Sciences of Philadelphia has received from Dr. Thomas Biddle a collection of anthropoid apes. It consists of mounted skins and skeletons of the gorilla, two adult specimens of the bald chimpanzee, young male of the common chimpanzee and an aged male orang. All were mounted by Umlauff of Hamburg. The gorilla is an adult male in perfect condition, and in life must have weighed at least three hundred and twenty-five pounds. At the regular meeting of the

academy on November 3, the collection was formally presented by Dr. H. C. Chapman and Mr. A. E. Brown, before the largest audience ever gathered in its lecture hall.

English papers state that Mr. F. du Cane Godman has recently presented to the British Museum (of which he is a trustee) a collection of nearly 30,000 specimens of beetles, following on a previous donation of 50,000. The present collection consists mainly of representatives of the family Elateridæ, the bulk being from Central America.

The fourteenth International Congress of Americanists will be held at Stuttgart from August 18 to 23, 1904, under the presidency of Professor Karl von den Steinen. The general secretary is Professor K. Lampert, Stuttgart, Archivstrasse 3.

A cablegram to the daily papers states that the *Terra Nova* arrived at Hobart, Tasmania, on October 1. The *Morning,* the relief ship of the Royal Geographical Society, is expected daily. The two vessels will start to the relief of the *Discovery* during the first week in December.

The Linnean Society of New South Wales has acquired the compass and sun dial used by Charles Darwin on the voyage in the *Beagle.*

The daily papers say that a meteorite, weighing from ten to twenty tons, has been discovered near Oregon City, Ore.

At recent sales in London a complete set of *Curtis's Botanical Magazine* from 1787 sold for £120; a copy of 'The Herball, or Generall Historie of Plantes,' 1597, for £15 15s., and 'De Arte Supputandi,' printed by R. Pynson, 1522, the first treatise in arithmetic published in England, for £20.

Nature states that the zebra stallion Matopo, which has been described and figured by Professor Cossar Ewart in his book 'The Penycuik Experiments,' and was the sire of some interesting zebra-horse hybrids, is dead. This zebra was purchased some time ago by Mr. Assheton-Smith, Vaynol Park, Bangor, who was hopeful that he might find it possible to repeat some of Professor Ewart's experiments, but unfortunately his expectations have not been realized. Whilst retaining the skin, he has presented the skeleton of the zebra to the University College of North Wales, where it will form a handsome addition to the zoological collection. It may also be noted that to this college Professor W. A. Herdman, F.R.S., of Liverpool, recently made a donation of some fishes from Ceylon and Indo-Malaya which he collected when in the east investigating the pearl fisheries of Ceylon. Professor D'Arcy Thompson, C.B., Dundee, has also presented a skeleton of the somewhat rare sea otter (Enhydra) from Alaska.

Word has come to the office of the United States Geological Survey that Mr. L. M. Prindle has completed the reconnaissance survey of the Forty-mile gold placers and also of the Seventy-mile placer fields in Alaska. He is now investigating the auriferous placers of the Birch Creek district, where he was joined by Mr. Alfred H. Brooks. Together they will make a hasty examination of the newly discovered gold fields on the lower Tanana River. Mr. Brooks spent a few days in the Juneau district with Dr. Arthur C. Spencer and Mr. Charles W. Wright. The areal mapping of the Juneau Special quadrangle has been completed, and the study of the ore bodies has been begun. Dr. Spencer will make a hasty examination of the important gold mines at Seward and Berner's Bay, on the east coast of the Lynn Canal, in the latter part of the season. Mr. Wright, before joining Dr. Spencer, spent about three weeks in the Porcupine placer district, which lies above the head of the Lynn Canal, near the International Boundary. His results, which included a study of the economic conditions, will be prepared for publication in the early part of the winter. Dr. George C. Martin spent the month of June in the Controller Bay oil fields, and in August visited the Cook Inlet oil fields. Mr. Brooks, who has charge of the Alaskan work, will return to Washington about the end of October, after visiting the two parties engaged in mapping the placers of the Nome region.

Major Powell-Cotton, of the British Army, has, according to Reuter's Agency, just completed a journey in Eastern Equatorial Africa

lasting 20 months. The expedition has resulted in some thousands of miles of hitherto unknown country being mapped, and in the discovery of six new tribes, including a race of so-called magicians. Data have also been collected regarding the cave dwellers of Mount Elgon. Fifty different species of animals have been secured, some of which will probably prove to be new to science. The explorer also succeeded in bringing back some perfect specimens of five-horned giraffes. For several months the expedition was traversing a region between the Upper Nile, Lake Rudolf and Lake Victoria in which no white men had previously set foot. Of the so-called magicians, whom Major Powell-Cotton came upon half way between Lake Rudolf and Lake Albert, and who in their appearance and their customs are quite distinct from any other tribe, he gives the following account: "Their villages were remarkable. Built of wattle and grouped together in dozens on the upper slopes of the hills, these dwellings were constructed with two storeys, the upper floor being approached through a dormer window, reached from the ground by means of a rude ladder. At no other point have I seen native houses consisting of two floors. These people, living in the higher altitudes, are able to grow corn, while the warlike natives in the plains below are scorched by drought, and yet in such awe are the magicians held that the starving people below, who outnumber the hill villagers by perhaps a thousand to one, have never been known to attack them. These people had never before seen a white man, and during the several days I spent in their country they were quite friendly and supplied us with food."

A BULLETIN from the Bureau of Forestry states that the Territorial Government of the Hawaiian Islands will appoint as superintendent of forestry this winter a man furnished it by the Bureau of Forestry, who will take charge of important projects for the betterment of the islands' forests. The man appointed will have the responsibilities first of determining the location and the boundaries of a system of forest reserves, and later of superintending a great deal of forest planting both on public and private lands. The forest conditions of the islands are unlike any that prevail in this country. Mr. William L. Hall of the Bureau of Forestry, who has just returned from a two months' examination of the islands, reports peculiar and interesting problems which forestry must solve there. The islands contain scarcely any forests capable of yielding timber of value for lumber. Nearly all the lumber used for building purposes comes from the Pacific Coast. But there are several hundred thousand acres of forest land of the greatest value for protective purposes. Indeed, so great is the importance of these forests that on their preservation depends the existence of the sugar industry, and that is equivalent to saying the continued prosperity of the islands. The sugar exports of the last fiscal year amounted to $25,000,000, and sugar is practically the only export. The raising of sugar requires an enormous amount of water, nearly all of which must be supplied by irrigation, the water being carried in flumes and ditches from the wet, mountainous parts of the islands to the dry plains on which the sugar cane is grown. The rainfall of the islands is nearly all confined to the northeast and east mountain slopes, where it is tremendously heavy, some years more than 200 inches. On the other side of the divide, and in the plains beyond, where the sugar cane grows, there may be no more than 15 inches of rain a year. The forests are largely confined to the rainy side of the mountains, and are necessary as a protective cover, to keep the ground from washing from the slopes and the rain from rushing back too rapidly into the sea. The presence of the forest cover, since it makes the stream flow regular, preventing both floods and periods of low stream flow, is indispensable to the success of irrigating projects. The value of this forest, strangely enough, consists not so much in the trees it contains—for they are frequently low, crooked, and sparsely scattered—as in the impenetrable mass of undergrowth beneath them. This undergrowth, composed of vines, ferns and mosses, is of so dense a character that it shades the ground absolutely and holds water like a sponge. It is, however, exceedingly delicate and easily destroyed. Let cattle into

such a forest and they will speedily eat or trample down the undergrowth till the bare ground is exposed. The soil then rapidly dries out and becomes hard, and the trees soon die. Grasses, insects and wind usually hasten the destruction. Cattle and goats have ravaged the Hawaiian forests without hindrance for many years and have worked further each year into the heart of the dense tropical growth. The Hawaiian public lands consist of 1,772,640 acres. All of these lands, which are in forest, and many forest areas privately owned which the government can gain possession of by exchange, will be put into forest reserves, cleared of cattle and goats, fenced and preserved.

Bradstreet's says editorially: The enormous losses already suffered in Texas and the immense power for evil, not only to that state but to the entire south, contained in the onward march of the so-called Mexican boll weevil, lends interest to the fact that a convention has been called to meet in Dallas, November 5, to consider ways and means of checking its ravages. Invitations have been sent out to all parts of the United States interested in this problem, and especially throughout the cotton producing states of the south, not only to those handling cotton itself but to all principal dealers in kindred lines. Fully one thousand delegates are expected to assemble to consider the subject. The question is getting to be a serious problem, not only with Texas producers but the entire cotton producing section of the United States, and those interested regard it as a question that should be studied and considered by every section of the United States. Under the caption 'The Cotton Weevil, a National Danger,' *Bradstreet's* some six months ago advocated a careful consideration of this subject by Congress, and the beginnings of systematic work were laid in an appropriation by Congress of a sum of money to be used in studying the pest and, if possible, finding something to check its progress. We know of no single subject that contains more of importance to the entire country's economic interests than the devising of measures to arrest and, if possible, eradicate this scourge to the principal agricultural interest of the south.

UNIVERSITY AND EDUCATIONAL NEWS.

The College for Women of the Western Reserve University has received from various donors $50,000 for the enlargement of the campus.

At the last meeting of the trustees of Columbia University, gifts amounting to $40,500 were acknowledged toward the fund for the purchase of South Field.

The board of directors of the College of Physicians and Surgeons of Philadelphia has instructed President H. C. Wood to appoint a committee to obtain plans for the proposed new library hall, on Twenty-second street, above Chestnut. The site was purchased some time ago, at a cost of $80,000. The college now has on hand a surplus of $24,000 toward the construction of the hall. Mr. Andrew Carnegie gave $50,000 for that purpose, and $54,000 was raised by the college.

The University of Wisconsin is planning to celebrate next June, with a week's exercises, the fiftieth anniversary of the first commencement.

William F. Durand, professor of Marine Engineering, has been appointed acting director of Sibley College, Cornell University, in place of the late Professor Thurston.

The following appointments have been made in the College of Physicians and Surgeons, Columbia University: Dr. Samuel W. Lambert, professor of applied therapeutics; Dr. Joseph A. Blake, professor of surgery; Dr. George E. Brewer, professor of clinical surgery; Dr. John S. Thacher, professor of clinical medicine; Dr. Frederick Peterson, clinical professor of psychiatry.

At the Illinois Wesleyan University, Dr. J. K. P. Hawks has been appointed instructor in bacteriology, Dr. J. Whitefield Smith, instructor in biology, and Mr. Bartgis McGlone, instructor in botany.

Earl Spencer has accepted the presidency of the Council of the Royal Agricultural College, Cirencester, in the room of the late Duke of Richmond and Gordon.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 20, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor. Professor J. McKeen Cattell, Garrison-on-Hudson, N. .

*THE MISUSE OF PHYSICS BY BIOLOGISTS AND ENGINEERS.**

THIS somewhat informal paper is preliminary to a paper which I have in preparation on statistical physics. My chief object in presenting this preliminary paper is to call attention to some of the precise notions of thermodynamics and to point out the essential limitations of that subject. Gibbs, for example, raises the question repeatedly in his writings as to the legitimacy of the thermodynamic discussion of things, such as thermoelectricity, which are associated necessarily with irreversible processes. What I have in mind concerning thermodynamics proper and concerning statistical physics is a general point of view which completely elucidates this question of Gibbs, setting precise limits not only to systematic thermodynamics, but to systematic physics in the broadest sense, and marking sharp boundaries between systematic physics and what we may call statistical physics.

A great deal is, I think, to be gained for science at the present time by insisting upon the sharp delimitation of those general ideas in physics which are related primarily to thermodynamics just as a great deal has been gained in the last half century by the sharp delimitation of those general ideas which relate primarily to

* A paper read before the American Physical Society on October 31, 1903.

mechanics. There is, I think, a widespread confusion of boundaries which makes this sharp delimitation a thing greatly to be desired, and I have chosen as the title of this preliminary paper 'The Misuse of Physics by Biologists and Engineers' for the reason that, in my opinion, these men, more than any others, violate in their philosophy the essential limitations of systematic physics and confuse the boundaries between systematic physics and statistical physics.

I do not wish this title to be taken as a challenge to biologists and engineers, but rather as suggesting, in a general way, the error of the indiscriminate application of the philosophy of the exact sciences in the study of natural phenomena. I do not expect, indeed, to make my position entirely clear until I have finished with what I have to say about statistical physics, but my position in brief is this, that the idea of quantitative relationships and the idea of one-to-one correspondence in general, as these ideas are known in physics, are inapplicable and necessarily fruitless in such fields as physical psychology and meteorology.

I am led to present this preliminary paper at this time from having read the recent presidential address of James Swinburne before the British Institution of Electrical Engineers and a subsequent paper on thermodynamics presented by Mr. Swinburne at the Southport meeting of the British Association in September.

Mr. Swinburne believes, apparently, that the precise ideas and methods of thermodynamics are unconditionally applicable to irreversible processes in general. I do not agree with him in this, and I do not think that the legitimacy and precision of the accepted ideas of thermodynamics especially as represented in the writings of Willard Gibbs can be questioned; but I do think that the notions of thermodynamics are precisely applicable to those types of irreversible processes which constitute permanently varying states, and approximately applicable to those irreversible processes which involve either approximate states of thermal equilibrium or approximately permanent states of variation. I shall point out the precise application of the ideas of thermodynamics to permanently varying states in this preliminary paper, reserving the discussion of approximate applications for a subsequent paper.

The fact is that the precise notions of systematic physics in general are essentially inapplicable in the world of actual phenomena, except in so far as these phenomena can be approximately correlated to *states of equilibrium* and to *permanently varying states* of material systems. I remember very distinctly the incredulity with which I first encountered, in my early study of physics, the unguardedly sweeping generalizations in the treatises which I then read, for example, on the elementary mathematical theory of electricity and magnetism. I could not believe that the phenomena of electricity and magnetism were quantitative in the sense that my then highly abstracted ideas of mechanical phenomena were quantitative.

In order to give some sort of a preliminary notion of what I have in mind in using the terms systematic physics and statistical physics I shall resort to classification.

Physics is divided into two branches, namely, systematic physics and statistical physics.

Systematic physics is again divided into mechanics and thermodynamics.

Mechanics, in the broad sense here defined, treats of those phenomena which can be to a high degree of approximation correlated in one-to-one correspondences to states of equilibrium and to simple types of sensible motion such as translatory mo-

tion, rotatory motion, motion involved in simple types of elastic distortion, steady types of fluid motion including wave motion and the corresponding types of force action. This definition of mechanics includes a large portion of the subjects of electricity and magnetism and of light. Mechanics, as here defined, includes all phenomena which involve action between bodies and regions of finite size, which action can be perceived directly or indirectly as a unit.

Thermodynamics treats of those phenomena which can be to a high degree of approximation correlated in one-to-one correspondences to states and processes involving thermal equilibrium and involving those permanently varying states which I have called steady sweeps. Thermodynamics involves much mechanics, but mechanics proper ignores everything which pertains strictly to thermodynamics. Thermodynamics includes all portions of the subjects of electricity and magnetism and light which are not completely defined in mechanical terms.

Statistical physics is the study of all the actual physical phenomena of nature, some of which, indeed, may be described in terms of the notions of ideal mechanics to a high degree of approximation, and some of which, indeed, may be described in terms of the notions of ideal thermodynamics to a high degree of approximation, but all of which are more or less erratic and in their minute details infinitely manifold, and in all of which the notion of one-to-one correspondence or of cause and effect, if one prefers that mode of expression, fails.

A clear understanding of the essential limitations of systematic physics is important to the engineer; it is, I think, equally important to the biologist, and it is of vital importance to the physicist, for in the case of the physicist, to raise the question as to limitations is to raise the question as to whether his science does after all deal with realities, and the conclusion which must force itself on his mind is, I think, that his science, the systematic part of it, comes very near, indeed, to being a science of unrealities. This is not necessarily to the discredit of the physicist, provided he knows it.

The engineer is not far wrong in his application of the principles of mechanics, for the engineer is chiefly concerned with integral relationships between finite things. Nevertheless, I think that the engineer frequently attempts to carry his mechanics too far, when, for example, he attempts anything but the crudest correlation in his studies of such things as friction and fluid motion. The phenomena of friction and of fluid motion can not be correlated—I do not mean by human means, conditionally as it were, but I mean that they absolutely can not be approximately correlated by any means in one-to-one correspondences. I discussed this matter briefly in some remarks before the American Institute of Electrical Engineers on December 19, 1902.* In studies which require the application of the principles of thermodynamics, on the other hand, engineers are, I think, frequently in error. Thus, Mr. Swinburne's difficulty—his statements, being partly right and partly wrong, may be taken to indicate a difficulty—seems to me to lie in an improper application of the principles of thermodynamics.

The biologist, on the other hand, is, I think, usually illogical when he attempts to make use of the ideas of systematic physics. The biological sciences, in so far as they are related to systematic physics at all, are related primarily to thermodynamics, and in so far as the biologist is unfamiliar with the principles of thermodynamics he can not make proper use of

* See *Trans. A. I. E. E.*, January, 1903, pp. 79–80.

any of the generalizations of systematic physics. I shall consider later the relations of biology and statistical physics, not, of course, from the point of view of the biologist, for this would be to discuss the relation of organism to environment, but in the light of some of the ideas of thermodynamics.

The biologist and the engineer need to have precise knowledge of thermodynamics, inasmuch as it is thermodynamics chiefly which determines the limits of correct application of the ideas and methods of systematic physics to natural phenomena.

This subject of thermodynamics is so little understood that I am not willing to proceed to a precise discussion of the questions set forth in a general way above, without first giving an outline of the fundamental ideas of thermodynamics, which I shall give as concisely and concretely as possible. I feel justified in taking your time in this way for the reason that here and there throughout my presentation you will find that the ideas are new, and, furthermore, I wish this paper to be readable by biologists and engineers.

In some instances I shall insist upon what may seem to be unnecessarily fine distinctions; but Whewell says very aptly that 'In order to acquire any exact solid knowledge the student must possess with perfect precision the ideas appropriate to that part of knowledge.' If there is any branch of physics where perfect precision of ideas is demanded it is, I think, in the subject of thermodynamics, especially if the boundaries between the legitimate realm of thermodynamics and the almost untouched realm of statistical physics are to be sharply defined.

Perfect precision of ideas is tested, as Whewell says, by the extent to which one perceives axiomatic evidence in a subject, and I give this sketch of thermodynamics exactly with the view of setting forth axiomatic evidences.

I. THERMAL EQUILIBRIUM.

When a substance is shielded from outside disturbance it settles to a state in which there is no tendency to further change of any kind. Such a state is called a state of *thermal equilibrium.*

When a substance has settled to thermal equilibrium it is said to have a definite temperature. The notion of temperature, that is the precise idea of temperature, as a physical fact is derived from the notion of thermal equilibrium. Also the idea of differences of temperature as physical facts (not as quantities) is derived from comparisons of states of thermal equilibrium.

The idea of thermal equilibrium applies to a limit which is never realized. It is impracticable to shield a substance completely. Failure of two kinds occurs, namely, failure to prevent exchange of energy between one system and another, either in the form of mechanical work or in the form of heat, and failure to prevent exchange of matter between one system and another. This second failure is very marked in the case of radioactive substances. Furthermore, our accepted notions as to the quickness with which a gas, for instance, settles to thermal equilibrium may be altogether wrong, for Boltzmann has pointed out that even a small mass of gas shielded completely in a vessel may, for all we know, require months to settle to anything approaching complete thermal equilibrium.

Before proceeding with this outline of thermodynamics I wish to state what is my opinion as to the influence which the kinetic theory (of gases) is destined to have upon the subject of thermodynamics. Several years ago, in writing a review of Duhem's elaborate mathematical development of thermodynamics, 'Mechanique Chemique,'

I contrasted the purely sensible basis and the abstract but inevitable mathematical structure of thermodynamics, on the one hand, with the mathematical theory of electricity and magnetism as it stands in Maxwell's 'Treatise,' on the other hand. Maxwell's theory is, of course, largely based on sensible things, but sensible things which are more or less inadequate to determine the essential elements of the theory, so that conception enters as an important and vital part of the theory. I stated that perhaps we are to have in thermodynamics a branch of physics which is to remain independent of conceptions, to remain, in other words, a purely algebraic structure resting upon an adequate foundation of axiomatic evidence which may be directly perceived. I do not now think that this is to be the case, but I think that the ideas of the kinetic theory, or, as Gibbs puts it, the ideas of statistical mechanics, are destined to become vital in the subject of thermodynamics; and I think that it is of the greatest importance in the treatment of thermodynamics, to reach conceptions of every fundamental notion with the help of the kinetic theory (statistical mechanics).

In view of my opinion as to the vital importance of statistical mechanics in thermodynamics, I shall suggest, whenever I can do so briefly, the molecular conceptions of the various notions of thermodynamics.

The Molecular Conception of Thermal Equilibrium.—The molecular motion at a given point in a gas (and no doubt in any substance) in thermal equilibrium is entirely erratic; an irregular and extremely rapid succession of fits and starts occurs as the molecules collide against each other, and the character of the molecular motion at the point is still further complicated by the fact that different molecules are continually passing the given point from every direction and with every variety of speed and oscillatory motion. Because of the enormous number of molecules in any perceptible volume of a substance it is the *average character* of the molecular motion, only, which has to do with temperature and pressure and in general with all thermal properties of substances; and, because of the enormous number of molecules, this average character of molecular motion is constant and uniform throughout a substance when the substance is in thermal equilibrium.

2. REVERSIBLE PROCESSES.

A substance in thermal equilibrium is generally under the influence of external agencies. Thus, surrounding substances confine the given substance to a certain region of space and they exert upon the given substance a constant pressure; surrounding substances are at the same temperature as the given substance and the molecules of the given substance rebound from surrounding substances with their motion, on the average, unchanged; surrounding substances may exert constant magnetic or electric influences upon the given substance, and so on. However, a substance can not be in thermal equilibrium when work is continually done upon or done by it, or when heat is continually given to or taken from it.

If the external influences which act upon a fluid in thermal equilibrium are made to change *very slowly,* causing the pressure and volume of the fluid to pass very slowly through a continuous series of values and in general involving the doing of work upon or by the fluid and the giving of heat to or taking of heat from the fluid, the fluid will pass slowly through *a process consisting of a continuous series of states of thermal equilibrium.* Such a process is called a *reversible process,* for the reason that the fluid will pass through the same

series of states in reverse order if the external influences are changed slowly so as to make the pressure and volume of the fluid pass through the same series of values in reverse order.

The characteristics of a reversible process are therefore as follows:

(*a*) A substance which undergoes a reversible process must be under varying *external* influence. A closed system can not perform a reversible process.

(*b*) A substance as it undergoes a reversible process is at each instant in a state of thermal equilibrium; and if, at a given instant during a reversible process, the external influences should cease to change, causing a sudden cessation of the doing of work on or by the substance, and of the interchange of heat between the substance and its surroundings, no commotion would be left in the substance.

(*c*) A reversible process must take place slowly, strictly with infinite slowness. An actual process, that is, a process which actually does proceed, can be only approximately reversible. Examples of reversible processes are given in the article on trailing sweeps, for it is important that it be clearly recognized that a reversible process is the limit which a trailing sweep approaches when it is performed more and more slowly.

3. SWEEPING OR IRREVERSIBLE PROCESSES.

While a substance is settling or tending to settle to thermal equilibrium it may be said to undergo a process. Such a process can not, in general, be arrested and maintained at any stage short of complete thermal equilibrium, but always and inevitably proceeds towards that state. Such a process is, therefore, called a *sweeping process* or simply a *sweep*.

A sweeping process takes place in one direction only, that is, if A and B are two successive stages of a sweep, stage B following stage A, then stage B grows out of stage A inevitably, but stage A can not be made to follow or grow out of stage B by any means whatever. A sweeping process, therefore, is irreversible.

Molecular Conception of the Sweeping Process.—While a gas (and perhaps any substance) is settling to thermal equilibrium, immediately after an explosion, for example, the character of the molecular motion at a given point changes rapidly from instant to instant and the character of the molecular motion at a given instant varies greatly from point to point in the gas; in other words, the gas is the seat of more or less violent turbulence while it is settling to thermal equilibrium.

The effects of mutual collision among the molecules, the effects of the collision of the molecules against the walls of the containing vessel and the effects of the confused movement* of the gas molecules from one part of the vessel to another part are always to even up the differences in the character of molecular motion in different parts of the vessel. On the other hand, the external influences which can be brought to bear on a substance act on all the molecules in the same general way, so that the tendency of a turbulent state of a gas to die away on account of the internal actions just pointed out can not be counteracted by external influences,† and,

* If a great number of white and black balls are placed in a box and shaken up, the confused motion tends to cause an even distribution of white and black balls throughout the box, for the reason that, of all possible arrangements of the balls, approximately even distribution is the most probable.

† The maintenance of an unending state of turbulence in a trailing sweep because of rapidly changing external influence is by no means a case in which the tendency of a turbulent state to die away is counteracted by external action, but rather a case in which the goal, namely the final state of thermal equilibrium, is made to recede continuously.

therefore, a sweeping process can not be arrested nor reversed by any means.

Note 1.—A fluid not in thermal equilibrium has no definite pressure, temperature or volume. The volume of a turbulent gas pertains only to the containing vessel. Any one, for example, who reads the reports of the measurement of the Holton and St. Albans base lines by the U. S. Coast and Geodetic Survey will appreciate the necessity of the projection of a region of thermal equilibrium into a space which is to be measured, and any one of course knows that the reality of the results of these measurements depends upon the fact that the earth's crust is approximately in thermal equilibrium.

One error in Mr. Swinburne's discussion of thermodynamics is in the extension of the notions of volume, pressure, temperature and entropy to substances not in thermal equilibrium. Points in Watt's diagram can represent only states of equilibrium, and lines in Watt's diagram can represent only reversible processes. I shall indicate in a subsequent paper the method which must be used when one wishes to extend engine calculations, for example, so as to include sweeping processes.

Note 2.—Writers on thermodynamics who are obliged to deal with irreversible processes or sweeping processes, that is to say, steam engineers, frequently introduce the notion of the integration of entropy and temperature. Thus Mr. Swinburne enlarges upon this procedure. He would assign a definite entropy and a definite temperature to each volume element of turbulent steam, and by integration arrive at the notion of total entropy and mean temperature. Now in the first place, when this method appears to give results a legitimate mode of calculating sweeps is really used, and the legitimate ideas involved are illogically expressed in terms of temperature and entropy. In the second place, *temperature and entropy have no meaning as applied to the elements of volume, even of a substance in thermal equilibrium,* not to mention the question of their application to the volume elements of a turbulent substance. This is a limitation of the ideas of thermodynamics which is indicated by the ideas of statistical mechanics. Whether this limitation can be justified independently of statistical mechanics I am not prepared to say with certainty. Thermodynamics has to do only with finite portions of matter, and infinitesimals have no meaning except as increments of finite quantities.

4. SIMPLE SWEEPS.

The settling of a closed system to thermal equilibrium is called a *simple sweep.*

Example.—The equilibrium of a mixture of oxygen and hydrogen in a closed vessel may be disturbed by a minute spark, and the explosion and subsequent settling of the aqueous vapor to a quiescent state without loss of heat constitute a simple sweep. The equilibrium of a gas confined under high pressure in one half of a two-chambered vessel may be disturbed by opening a cock which connects the two chambers, and the rush of gas into the empty chamber constitutes a simple sweep.

5. TRAILING SWEEPS.

When external influences change continuously, a substance in its tendency to settle to equilibrium never catches up, as it were, with the changing conditions, but trails along behind them, and we have what is called a *trailing sweep.*

Examples.—The rapid expansion or compression of a gas in a cylinder is a trailing sweep. So long as the piston moves at a perceptible speed, the gas, in its tendency to settle to equilibrium, never catches up with the varying conditions. This is evi-

dent, for any one can see that a sudden stoppage of the piston would leave some slight turbulence in the gas, which would not be the case if the gas were in equilibrium at the instant the piston is stopped. When the piston is moved more and more slowly, the departure of the gas from strict thermal equilibrium at each stage of the expansion or compression becomes less and less, and the expansion or compression approaches more and more nearly to a reversible process.

The rapid heating (or cooling) of a gas in a closed vessel is a trailing sweep. So long as heat is given to the gas at a perceptible rate there will be perceptible differences of temperature in different parts of the gas; the gas in its tendency to settle to thermal equilibrium never catches up with the increasing temperature of the walls of the containing vessel.

When the gas is heated (or cooled) more and more slowly, that is, when heat is given to the gas at a rate which becomes more and more nearly imperceptible, then the departure of the gas from strict thermal equilibrium at each stage of the heating process becomes less and less, and the heating (or cooling) approaches more and more nearly to a reversible process.

6. STEADY SWEEPS.

A substance may be subjected to external action which, although unvarying, is incompatible with thermal equilibrium. When such is the case the substance settles to a permanent or unvarying state which is not a state of thermal equilibrium. Such a state of a substance is called a *steady sweep*.

Examples.—The two faces of a slab or the two ends of a wire may be kept permanently at different temperatures. When this is done the slab or wire settles to an unvarying state which is by no means a state of thermal equilibrium. Heat flows through the slab or along the wire from the region of high temperature to the region of low temperature, *never* from the region of low temperature to the region of high temperature. This flow of heat through the slab or along the wire is an irreversible process and it constitutes a steady sweep.

The ends of a wire may be kept permanently at different electric pressures, for example, by connecting the wire to the terminals of a battery or dynamo. When this is done a steady electric current flows along the wire, the battery does work steadily on the wire, and this work reappears steadily as heat in the wire. Reversal of the current *does not* reverse this process and cause heat energy to disappear in the wire (cooling the wire) and reappear as work done on the battery by the wire, but the process is irreversible and it constitutes a steady sweep.

The notion of steady sweeps is of the utmost importance in thermodynamics inasmuch as thermodynamics treats directly of states of thermal equilibrium and of steady sweeps only.

The notion of entropy is involved in the notion of a steady sweep; and the notion of temperature is involved in the notion of thermal equilibrium.

7. THERMODYNAMIC DEGENERATION AND REGENERATION.

A sweeping process always plays a certain havoc, or effects a certain *degeneration* in a system. Thus, there is a certain degeneration associated with the escape of a compressed gas through an orifice; there is a certain degeneration associated with the flow of heat from a region of high temperature to a region of low temperature; there is a certain degeneration associated with the direct conversion of work into heat, and so on.

In a simple sweep the degeneration lies wholly in the relation between the

initial and final states of the substance which undergoes the sweep, inasmuch as, in a simple sweep, no outside substance is affected in any way, no work is done on or by the substance which undergoes the sweep, and no heat is given to or taken from it.

In a trailing sweep the degeneration may lie partly in the relation between the initial and final states of the substance which undegoes the sweep, partly in the direct conversion of work into heat and partly in the direct transfer of heat from regions of high temperature to regions of low temperature.

In a steady sweep the substance which undergoes the sweep remains entirely unchanged as the sweep proceeds, and the degeneration lies wholly in the direct conversion of work into heat, in the direct transfer of heat from a region of high temperature to a region of low temperature, or both.

A substance which has undergone a sweeping process may be brought back to its initial state, or *regenerated,* by a reversible process; but when a substance is regenerated by a reversible process, the external action necessary to bring about the reversible process involves an equal degeneration of some external substance; that is, the regeneration of a substance by a reversible process always involves the creation of an equal external regeneration. This is, in fact, a statement of the second law of thermodynamics.

The entire subject of thermodynamics, in so far as it does not have to do with the specific thermal properties of particular substances, is based upon the consideration of the two kinds of thermodynamic degeneration which are involved in steady sweeps, that is, upon: (*a*) The thermodynamic degeneration which is represented by the direct conversion of work into heat, and the thermodynamic regeneration which is represented by the conversion of work into heat by a reversible process; and (*b*) The thermodynamic degeneration which is represented by the direct transfer of heat from a region of high temperature to a region of low temperature, and the thermodynamic regeneration which is represented by the transfer of heat from a low temperature region to a high temperature region by a reversible process.

The following two propositions concerning the two kinds of thermodynamic degeneration (*a*) and (*b*) follow at once from a consideration of steady sweeps.

Proposition (A).—The thermodynamic degeneration represented by the direct conversion of work into heat at a given temperature is *proportional* to the quantity of work so converted.

Proof.—Consider a steady flow of electric current in a wire. This process being steady, the amount of degeneration occurring in a given interval of time must be proportional to the time. The amount of work converted into heat is also proportional to the time. Therefore the amount of degeneration is proportional to the amount of work converted into heat. Of course the temperature must be invariable, or the process can not be thought of as remaining identically the same from instant to instant. The dependence of this kind of degeneration upon temperature will be considered later.

Corollary.—The thermodynamic regeneration which is represented by the conversion of heat at a given temperature into work by a reversible process is proportional to the heat so converted.

Proposition (B).—The thermodynamic degeneration represented by the direct transfer of heat from a given high temperature T_1 to a given low temperature T_2 is proportional to the quantity of heat transferred.

Proof.—Consider a steady flow of heat

from temperature T_1 to temperature T_2 constituting a steady sweep. This process being steady, the degeneration occurring in a given interval of time must be proportional to the time. The quantity of heat transferred is also proportional to the time. Therefore, the amount of degeneration is proportional to the quantity of heat transferred. The dependence of this kind of degeneration upon temperature will be considered later.

Corollary.—The thermodynamic regeneration which is represented by the transfer of heat from a low temperature T_2 to a high temperature T_1 by a reversible process is proportional to the heat transferred.

8. THE SECOND LAW OF THERMODYNAMICS.

(*a*) The degeneration of a system which accompanies a sweeping process can not be directly repaired, nor can it be repaired by any means without the creation of a compensating degeneration in some other system.

This is an entirely general statement of the second law. The *direct repair* of the degeneration due to a sweeping process means the undoing of the havoc wrought by the sweep by allowing the sweep to *perform itself backwards!* This notion of *direct repair* is introduced into this general statement of the second law in order that each of the following particular statements of the law, namely, (*b*), (*c*) and (*d*) may correspond exactly in form to the general statement (*a*). A slightly modified general statement of the second law is the following:

(*a*) Thermodynamic degeneration and regeneration are always balanced in a reversible process, while degeneration always exceeds regeneration in any process which is in any way sweeping in character.

(*b*) Heat can not pass directly from a cold body to a hot body, nor can heat be transferred from a cold body to a hot body by any means without compensation.

(*c*) Heat can not be converted directly into work, nor can heat be converted into work by any means without compensation.

The direct conversion of heat into work (see discussion following (*a*) above) would be simply the reverse of any of the ordinary sweeping processes which involve the degeneration of work into heat. Thus, work is degenerated into heat in the bearing of a rotating shaft, and we all know that to reverse the motion of the shaft will not cause the bearing to grow cold and the heat so lost to appear as work helping to turn the shaft!

(*d*) A gas can not pass directly from a region of low pressure to a region of high pressure, nor can a gas be transferred from a region of low pressure to a region of high pressure by any means without compensation.

The compensation involved in the transfer of a gas from a region of low pressure to a region of high pressure by means of a pump is the degeneration into heat of the work spent in driving the pump.

The repeated statement of self-evident facts in these statements of the second law of thermodynamics may seem ridiculous to the intelligent reader, but it must be remembered that but few persons realize that the second law of thermodynamics is a statement of a fact which every one knows, together with a generalizing clause which when once thoroughly understood is almost if not quite self-evident. I can not refrain from one more statement of the second law, the oldest English version of it:

Humpty Dumpty sat on a wall.
Humpty Dumpty had a great fall.
All the King's horses and all the King's men
Can not put Humpty Dumpty together again.

This is perhaps the most dignified of all the statements of the second law of thermodynamics, inasmuch as it omits all nonsense about *direct repair* and refers at once to external means.

The reader must not imagine, however, that thermodynamic degeneration has anything to do with structural degeneration or dissolution, which is the most prominent feature of the calamity which befell Humpty Dumpty, but, to put the case concretely, if one shakes up a quantity of pure and homogeneous water in a bottle, one plays that irreparable havoc which constitutes thermodynamic degeneration.

9. ENGINES.

The further development of the subject of thermodynamics depends upon the establishment of the exact relation between the degeneration which is represented by the transfer of heat from a high to a low temperature and the degeneration which is represented by the conversion of work into heat. To establish this relation it is necessary to consider a *reversible process* in which the degeneration of heat from high to low temperature is compensated by the regeneration of heat into work, or *vice versa.*

The engine is a machine which determines such a process. The ordinary engine, indeed, is subject to friction, and the steam as it passes through the engine does not undergo a reversible process; but if the engine were frictionless, if it were driven slowly, if the cylinder were prevented from cooling the steam, if the steam were expanded sufficiently to prevent puffing and if the feed water were heated, in a 'regenerative' feed water heater, to boiler temperature before entering the boiler, then the processes involved in the operation of the engine would be reversible. Such an ideal engine we will call a *reversible engine* or a *perfect engine.*

During a given interval of time the engine takes an amount of heat H_1 from the boiler at temperature T_1, it converts into work W a certain fractional part of H_1 and delivers the remainder H_2 to the condenser at temperature T_2.

The work W done by the engine is equal to the difference $H_1 - H_2$ according to the first law of thermodynamics. That is,

$$W = H_1 - H_2. \qquad (1)$$

Now, all the heat used in the engine comes from the region at temperature T_1, and the net result of the operation of the engine is: (a) to convert the quantity $W(= H_1 - H_2)$ of heat from temperature T_1 into work, and (b) to transfer the quantity H_2 of heat from temperature T_1 to temperature T_2. The result (a) involves an amount of regeneration which is proportional to W, temperature being given; this regeneration may, therefore, be represented by mW where m is a constant depending *only* on the temperature T_1. The result (b) involves an amount of degeneration which is proportional to H_2, temperatures being given; this degeneration may, therefore, be represented by nH_2 where n is a constant depending *only* on the temperatures T_1 and T_2. If the engine is reversible we must have

$$mW = nH_2, \qquad (2)a$$

or, using the value $(H_1 - W)$ for H_2, and solving for W we have

$$W = \frac{n}{m+n} H_1, \qquad (2)b$$

in which $n/(m+n)$ depends on T_1 and T_2, *only,* irrespective of the kind of engine and of the physical properties of the fluid employed in the engine, provided, only, that the engine is reversible. The fractional part $n/(m+n)$ of the heat H_1 which the engine converts into work is called the efficiency of the engine, and from equation $(2)b$ it follows that *the efficiency of all reversible engines is the same for given values of the temperatures T_1 and T_2.*

If the operation of the engine involves sweeping processes of any kind then the degeneration nH_2 exceeds the regeneration mW or

$$mW < nH_2,$$

or, using the value $(H_1 - W)$ for H_2, and solving for W we have

$$W < \frac{n}{m+n} H_1, \tag{3}$$

in which m and n have the same values as in equation (1). Comparing this with equation (2)b it follows that *any irreversible engine working between given temperatures T_1 and T_2 has less efficiency than a reversible engine working between the same temperatures.*

10. THERMODYNAMIC DEFINITION OF THE RATIO OF TWO TEMPERATURES.

According to article 9 the ratio, H_1/H_2, of the heat taken from the boiler to the heat given to the condenser by any reversible engine working between the given temperatures T_1 and T_2 is invariable, and it can be easily shown that this ratio approaches unity as T_1 and T_2 approach equality. Therefore, the ratio of the two temperatures T_1/T_2 may be defined as the ratio of the two heats H_1/H_2. That is:

$$\frac{T_1}{T_2} = \frac{H_1}{H_2}. \tag{4}$$

11. ENTROPY. THERMODYNAMIC DEGENERATION.

The statement of the second law of thermodynamics can scarcely be looked upon as complete until a precise and complete numerical measure of thermodynamic degeneration has been established. This numerical measure of thermodynamic degeneration is called entropy. The notion of entropy may be completely developed by consideration of steady sweeps. I will give this development first and I will give Clausius's development afterwards in order to point out an error in Clausius's discussion.

Referring to article 9 we may write the expression for the regeneration mW in the form $f(T_1) \cdot W$ inasmuch as m is a function of T_1 only.

The degeneration nH_2 may be written

$$[f(T_2) - f(T_1)]H_2,$$

inasmuch as the degeneration associated with the transfer of the heat H_2 from T_1 to T_2 may be thought of as (a) the regeneration of H_2 from temperature T_1 to work, and (b) the degeneration of this resulting work to heat at temperature T_2; in which case the regeneration (a) is $f(T_1) \cdot H_2$ and the degeneration (b) is $f(T_2) \cdot H_2$.

Therefore, equation (2)a may be written

$$f(T_1) \cdot W = [f(T_2) - f(T_1)]H_2.$$

Using equation (1) and equation (4) we have

$$\frac{f(T_2) - f(T_1)}{f(T_1)} = \frac{T_1 - T_2}{T_2}.$$

From which the function f is to be determined. Differentiating with respect to T_2 we have

$$\frac{f'(T_2)}{f(T_1)} = -\frac{T_1}{T_2^2} = -\frac{\frac{1}{T_2^2}}{\frac{1}{T_1}};$$

and, therefore, since T_1 and T_2 are independent of each other we have

$$f(T_1) = \frac{1}{T_1}.$$

That is to say, the thermodynamic degeneration associated with the conversion of an amount of work W into heat at temperature T_1 is equal to W/T_1, and the thermodynamic degeneration associated with the transfer of an amount of heat H_2 from temperature T_1 to temperature T_2 is

$$\frac{H_2}{T_2} - \frac{H_2}{T_1}.$$

Clausius's derivation of the numerical measure of entropy is based upon the idea that degeneration and regeneration are balanced in a reversible process. In this derivation it is necessary to consider a cyclic process (reversible) in order that no outstanding change of state may be left as a result of the process, so that one need consider only the exchange of work and heat between the substance which is being studied and external substances, and in particular one is not under the necessity of considering the amount of degeneration or regeneration involved in the change of state of a particular substance.

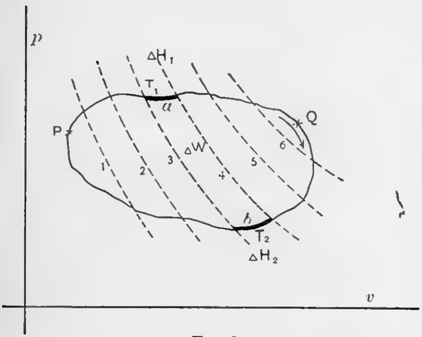

FIG. 1.

Consider a fluid, which, starting from the state P, Fig. 1, is made to pass through a reversible cyclic process and return to the state P by any combination whatever of slow heating and cooling, expanding and compressing. The closed curve represents the cyclic process, and the moving point Q as it moves along the process curve represents the changing state of the fluid.

A clear idea of the external actions which take place may be obtained by drawing a series of adiabatic or isentropic lines (an isentropic line represents the variation of pressure with volume when the fluid neither gives off nor receives heat). The fluid is receiving heat while Q is crossing isentropic lines from small numbers to large numbers in Fig. 1, and giving off heat while Q is crossing isentropic lines from large numbers to small numbers. The fluid is expanding and doing external work when Q is moving to the right, and contracting and having work done upon it when Q is moving to the left. The fluid is in general at high temperature for those positions of Q where p and v are both large, and at low temperatures for those positions of Q where p and v are both small.

Consider two portions, a and b, of the given process curve which lie between a pair of isentropic lines. Let T_1 be the high temperature of the fluid when Q is passing along a, and let dH_1 be the amount of heat taken in by the fluid while Q is passing along a. Let T_2 be the low temperature of the fluid when Q is passing along b, and let dH_2 be the amount of heat given off by the fluid while Q is passing along b.

Consider the reversible cyclic process which is represented by the two portions a and b of the given process curve, together with the isentropic lines between which a and b lie. We will call this cyclic process an elementary cyclic process to distinguish it from the given process. The net result of the elementary cyclic process would be the taking in of the quantity dH_1 of heat at T_1, the conversion of a definite fraction dW of this heat into work and the giving off of the remainder, dH_2, of the heat at temperature T_2. Therefore, according to Arts. 9 and 10 we have

$$\frac{dH_1}{dH_2} = \frac{T_1}{T_2}. \qquad \text{(i)}$$

Now, dH_1 is heat received by the fluid, and dH_2 is heat given off by the fluid, and one or the other should be considered as negative, say dH_2, then equation (i) should be written:

$$-\frac{dH_1}{dH_2}=\frac{T_1}{T_2}, \tag{ii}$$

or

$$\frac{dH_1}{T_1}+\frac{dH_2}{T_2}=0. \tag{iii}$$

The whole of the given cyclic process may be broken up into pairs of corresponding parts like a and b, so that the entire heat taken in and given out by the fluid during the given process consists of parts which correspond in pairs like dH_1 and dH_2, and each pair of heat parts satisfies an equation like (iii). Therefore, *the sum of all quotients obtained by dividing the heat taken in by a fluid at each step of any reversible cyclic process by the absolute temperature of the fluid at the step is equal to zero.* That is

$$\Sigma\frac{dH}{T}=0 \tag{5}$$

for any reversible cyclic process.

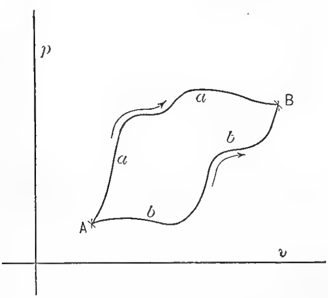

FIG. 2.

Consider two states of thermal equilibrium of a fluid represented by the points A and B, Fig. 2. Let the lines a and b represent any two different reversible processes leading from A to B. Then process a together with process b *reversed* constitute a cyclic process starting from A and returning to A. Therefore the sum $\Sigma\, dH/T$ is equal to zero when it is extended over process a and over process b *reversed*. Putting this into symbolic form we have:

$$\sum_a\frac{dH}{T}+\sum_{-b}\frac{dH}{T}=0, \tag{iv}$$

in which the subscript a indicates that the first summation is extended over process a, and the subscript $-b$ indicates that the second summation is extended over process b *reversed.*

But

$$\sum_{-b}\frac{dH}{T}=-\sum_b\frac{dH}{T}. \tag{v}$$

That is, the summation $\Sigma\, dH/T$ extended over the process b *reversed* is equal but opposite in sign to the value of this summation $\Sigma dH/T$ extended over the process b not reversed, that is, when process b leads from state A to state B.

Substituting the value of $\Sigma dH/T$ from equation (v) in equation (iv) we have

$$\sum_a\frac{dH}{T}=\sum_b\frac{dH}{T}. \tag{6}$$

That is, *the sum* ($\Sigma\, dH/T$) *has the same value for any two, and therefore, for all reversible processes which lead from one given state of thermal equilibrium A to another given state of thermal equilibrium B.*

If the state B is one which can be reached from state A by a sweeping process, then the sum ($\Sigma\, dH/T$) extended over a reversible process leading from A to B is *positive* in value. Therefore the value of the sum ($\Sigma\, dH/T$) extended over any reversible process leading from state A to state B of a substance *may be used as a measure of the thermodynamic degeneration* which is associated with the change of the substance from state A to state B. This sum is called the *increase of entropy* of the substance. When the sum ($\Sigma\, dH/T$) is negative it measures a thermodynamic regeneration and is called a *decrease of entropy.*

Examples.—A gas is allowed to sweep through an orifice and increase in volume from v to V with imperceptible change of temperature. The same gas is then expanded slowly in a cylinder from volume v to volume V without change of temperature. To prevent change of temperature heat must be given to the gas at each step of the expansion (dH positive), and therefore the sum ($\Sigma dH/T$) is positive.

A gas is heated at constant volume by the degeneration of work into heat. The same result may be accomplished reversibly by heating the gas slowly on a stove. In this latter process dH is positive at each step and the sum ($\Sigma dH/T$) extended over the slow heating process is positive.

The creation of an external compensating degeneration (decrease of entropy) when the effect of a sweeping process is repaired by a reversible process may be expressed by the entropy change of external substances. Thus in each of the above examples the reversible process involves the taking of heat from external substances so that the sum ($\Sigma dH/T$) is negative as applied to the external changes which are involved in the reversible processes mentioned, or in other words, external substances suffer an increase of entropy when a given substance has its entropy decreased by a reversible process.

In general the thermodynamic degeneration associated with a sweeping process can be represented as an increase of entropy (summation of dH/T as above explained) only by devising a reversible process which produces the same change as the given sweep so far as the substance under consideration is concerned. In the case of steady sweeps, however, it is not *necessary* to devise a reversible process for producing the same result in order to represent the result of a steady sweep as an increase of entropy. The entropy increase which is associated with a steady sweep may be derived from a consideration of the reversible processes which always accompany a steady sweep, using Clausius's summation $\Sigma dH/T$, as follows:

Consider the *slow* flow of heat from a body A at temperature T_1 to a body B at temperature T_2. The transfer of heat being slow, the cooling of A and the heating of B are reversible processes, and A and B are at each instant in thermal equilibrium.

While an amount of heat H is transferred the decrease of entropy of body A is $\Sigma dH/T = H/T_1$ and the increase of entropy of body B is $\Sigma dH/T = H/T_2$, so that the net increase of entropy due to the steady sweep is $(H/T_2 - H/T_1)$.

Consider a fine wire submerged in a large vessel of water at temperature T, heat being slowly generated in the wire by an electric current. Then the water will be at each instant in thermal equilibrium, that is, the heating of the water will be a reversible process to which Clausius's summation may be applied. Thus, while the water receives an amount of heat W (measured in terms of the work lost in the wire), the value of $\Sigma dW/T$ will be W/T, which is the increase of entropy of the water. In this case there is no decrease of entropy anywhere; so that W/T measures the thermodynamic degeneration involved in the conversion of the work W into heat at temperature T.

Absolute Values of Entropy.—Entropy changes or entropy differences only have real physical significance. However, a certain state of a substance may be arbitrarily chosen as a zero state or reference state and the absolute value of the entropy of the substance in any other given state may be defined as the value of Clausius's summation extended over any reversible process leading from the zero state to the given state. This is equivalent to assigning arbitrarily the value zero to the entropy of the substance in the zero state.

The entropy of a substance in a given state is proportional to the mass of the substance, for doubling the mass will double the value of dH for each step of any reversible process. Entropy is, of course, expressed in *units of heat per degree of temperature.*

Remark.—Equation (5), due to Clausius, was further generalized by Clausius so as to apply in his opinion to cyclic processes which are not reversible, in which case, according to Clausius, equation (5) becomes

$$\Sigma\frac{dH}{T} > 0.$$

This extension of the integral $\Sigma dH/T$ to include sweeping processes is incorrect except in so far as steady sweeps are concerned as explained above.

12. SUMMARY.

The precise idea of temperature is associated with the notion of thermal equilibrium, and the precise idea of temperature has nothing to do with the sensations of hot and cold. The electric arc, for example, is very hot, but it has no temperature.

The error of Clausius in extending his summation to irreversible processes lies in the fact that in general the idea of temperature utterly fails in such cases, and the summation $\Sigma dH/T$ has no meaning whatever. Of course, this summation may always be applied to the reversible changes (when they exist) which take place in the external substances which envelop the substance which is undergoing the irreversible process.

Not only is the precise idea of temperature limited to substances in thermal equilibrium, but it applies only to a finite portion of a substance. It is meaningless to speak of the temperature of a molecule.

There are many cases of steady sweeps, such as thermal conduction in a gas, steady electric discharge through a gas, steady radiation from a hot to a cold region, in which the sweeping substance, be it material or ether, is far from being in thermal equilibrium, although in a permanent or unvarying state. The precise idea of temperature is not applicable to such states. Thus radiation in space has no definite temperature unless the space is enclosed in an envelope which is in thermal equilibrium, in which case the radiation is the normal radiation for the given temperature, and the space occupied by the radiation has, in fact, the same temperature as the adjacent material.

When normal radiation issues from an aperture in an enclosure it becomes attenuated as it travels farther and farther from the aperture, and this attenuated radiation (absorption of medium supposed to be nil), although conforming to a simple law of distribution of energy among its various phases, has not a definite temperature. Neither does a monochromatic beam of light have a definite temperature.

In general, all cases of molecular motion and of ether motion (radiant heat) in which some definite and unvarying function exists expressing the distribution of energy among the various phases of the motion, are to be classed as steady sweeps. In all such cases the precise idea of temperature is inapplicable to the sweeping substance or space. Still, all such processes are amenable to precise and systematic treatment. This systematic treatment always depends upon a knowledge of the function of distribution of energy among the phases, *and the characteristics of the sweeping substance or space are properly described in terms of this function, not in terms of temperature and entropy.*

It is true, however, that a generalized idea of entropy, for example, can be ap-

plied to steadily sweeping substances. Thus Boltzmann's H function, which has a minimum value and closely corresponds to entropy when a gas is in thermal equilibrium, has a definite value for any steady state of a gas other than thermal equilibrium.

Entropy always increases in natural phenomena, and the notion of entropy is, perhaps, much more intimately related to the notion of time than any other physical notion whatever. The notion of entropy seems to me, indeed, to be the very foundation of the notion of time as a physical fact, although the numerical evaluation of time depends, in practice, upon the approximate realization of some of the precise ideas of mechanics.

This intimate relationship of the notions of entropy and time gives very great emphasis to the two propositions A and B in article 7 in which increase of entropy appears as measured by elapsed time.

Heretofore the idea of the increase of entropy associated with a sweeping process has been thought by the ablest writers on thermodynamics, such as Willard Gibbs, to be dependent upon the devising of a reversible process which leads to the same change of state as the given irreversible process. This is, I think, true in regard to sweeping processes in general, but it is not true in regard to steady sweeps.

The characteristic features of irreversible processes are, in my opinion, very clearly suggested by the term sweep and by the special terms simple sweep, trailing sweep and steady sweep, and I urge the adoption of these terms.

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Lehigh University.

METEOROLOGY AT THE BRITISH ASSOCIATION.

Contrary to custom, meteorology took foremost place at the Southport meeting of the British Association. This was largely due to the efforts of Dr. W. N. Shaw, the head of the British Meteorological Office, by whose invitation the International Meteorological Committee met with the British Association for the Advancement of Science and for the first time in England since 1876. The attendance of a majority of the members of the committee justified the innovation, and before going to Southport they were able to meet some representative British men of science at a dinner in London given by Dr. Shaw. Of the seventeen members constituting the International Meteorological Committee, the following ten were present at Southport: the president, Professor Mascart, of Paris; the secretary, Professor Hildebrandsson, of Upsala; Dr. Shaw, of London; Dr. Paulsen, of Copenhagen; Professor Mohn, of Christiania; Dr. Snellen, of Utrecht; General Rykatcheff, of St. Petersburg; Professor Pernter, of Vienna; Professor Hellmann, of Berlin; and Professor Moore of Washington. Although the United States has had a representative in the committee for twelve years, only now, for the first time, was a meeting attended by the chief of the Weather Bureau, indicating the present desire of this country to cooperate in international meteorology. Besides the above, there came for the discussion of meteorological telegraphy, Professor van Bebber from Hamburg and Captain Chaves from the Azores; and of the sub-committee for scientific aeronautics its chairman, Professor Hergesell from Strasburg, M. Teisserenc de Bort from Paris, and the writer. The sessions of the committee lasted five days and the questions considered related principally to details of administration, publication and observation. Of greater scientific interest was an apparatus, shown by Dr. Paulsen, for the collection of atmospheric electricity by the employment of radioactive salts, and a

new hair hygrometer, exhibited by Professor Pernter as superior to the psychrometer. A commission, consisting of Sir Norman Lockyer, Dr. Shaw, Professor Pernter and M. Angot, was appointed to consider the study of the relations of solar physics to meteorology, and it was decided to support the resolutions of the Royal Saxon Academy of Sciences relative to the organization of investigations in atmospheric electricity. After hearing Professor Hergesell's report on the progress in exploring the atmosphere with kites and balloons, the continuation of this work, especially its prosecution in England, was recommended, and the writer's project, to explore the atmosphere above the tropical oceans by means of kites flown from a steamship, received hearty endorsement. It was announced that the committee for scientific aeronautics would meet at St. Petersburg next August, and that the general committee would assemble at Innsbruck in September, 1905. Dr. Snellen resigned from the committee, in consequence of his retirement as director of the meteorological service of the Netherlands, and was succeeded by M. Lancaster, chief of the meteorological service of Belgium. Professor Hellmann, who had recently taken Professor von Bezold's place on the committee, agreed to codify the resolutions that had been adopted at the various meetings since the Vienna Congress of 1873.

In the Physical Section of the British Association meteorology also predominated, the chief topics discussed being the relations of solar activity to meteorology and the exploration of the upper atmosphere. Great interest was manifested in the use of kites for the latter purpose, and this was especially gratifying to the writer, who first advocated the method at the Liverpool meeting of the Association in 1896, and in consequence of the growing interest has since presented annual reports of the results obtained with kites at Blue Hill and on the Atlantic Ocean. The Physical Section was divided into two subsections, and in one of these meteorology was recognized as a distinct branch of physics. Dr. Shaw was chairman of the department of astronomy and meteorology, and it is believed that his introductory address is the first treating exclusively of meteorology which has been given before the Association for many years. The subject was 'Methods of Meteorological Investigation,' and after mentioning the good work accomplished by the several members of the committee and by others, Dr. Shaw declared that meteorology in Great Britain needed the aid of the universities. The topic of simultaneous solar and terrestrial changes was introduced by Sir Norman Lockyer's paper, in which, from a comparison of rainfall and barometric observations in India with solar prominences, the author concluded that the latter are not only the primary factors in the magnetic and atmospheric changes occurring in our sun, but that they are also the instigators of the terrestrial variations. (This paper is reprinted in SCIENCE, pp. 611–623.) Professor Hildebrandsson confirmed the general conclusions of Sir Norman as to the 'surgings' of the barometric pressure, while Professor Hellmann and Dr. Buchan corroborated the coincidence found between rainfall and sunspots, using the data for other years. Father A. L. Cortie, of Stonyhurst, spoke of the recent researches made by Father Sidgreaves, Dr. Chree and himself on the question of the relation between sun spots and terrestrial magnetism. Sir Norman Lockyer, he said, had raised the question as to whether prominences might not supply the place of sun spots in cases where a great magnetic storm was unaccompanied by sun spots. By a series of observations he had made, and by the observations of Father Fenyi,

of Kalocsa, they had come to the conclusion that in no single case could a magnetic storm be with certainty associated with any given prominence, and great disturbances had occurred without any answering swing of the needles. It was, they thought, the general disturbance of the sun and his surroundings which affected the earth's magnetism, and not any particular manifestation of spot or prominence.

The important subject of the investigation of the upper atmosphere was opened for consideration by Mr. W. H. Dines' report of the joint committee of the Association and Meteorological Society on obtaining meteorological observations with kites, which were flown from a steamer off the west coast of Scotland during the past summer. Owing to the slowness of the vessel chartered and the bad weather, the experiments were not very successful, 20 records being obtained in 38 flights, with a maximum height of only 6,000 feet. In his sixth report upon meteorological kite-flying at Blue Hill, the writer stated that during the years 1901–2 the average height reached in the 23 flights was 7,900 feet, with a maximum of 14,060 feet. Some deductions concerning the decrease of temperature in cyclones and anti-cyclones were given and the project of exploring the atmosphere in the tropics by kites flown from a steamer was explained, as is outlined in SCIENCE, Vol. XVII., pp. 178–9.

General Rykatcheff described experiments of raising kites in a calm from a Russian warship, steaming twelve knots. M. Teisserenc de Bort traced the circulation of the air around barometric depressions, as evinced by the trajectories of his balloons, and from experiences with kites in Denmark he suggested that the meteorographs carried by them should etch their records on copper, so that these might be preserved in case the instruments fell into the water. Professor Hergesell gave a résumé of the operations of the International Committee for Scientific Aeronautics since its foundation in 1896. For several years monthly ascensions of balloons have been conducted in various parts of Europe, but permanent stations, where kite flights can be made daily, are desired. A kite station was maintained during nine months in Denmark and, since the first of the year, kites, or captive balloons, have been sent up each morning from Berlin and kites less regularly from Hamburg. The monthly observations are collected by Professor Hergesell and published at the expense of the German government. The establishment of an aeronautical observatory in the British Isles would be of great importance for these studies. Professor A. Schuster insisted upon the value of the information that could be derived from kites, and although unmanned balloons can attain the greatest altitudes, he hoped that balloons carrying aeronauts would be included in the program of work, since, with them, samples of air for analysis could be collected from the high strata of the atmosphere and personal observations made of various phenomena. He considered it most important for England to take a proper part in these investigations by placing the Meteorological Office on an altogether different basis, and a discussion of the question at the present time, when so many distinguished foreigners testified as to its importance, appeared appropriate. Professor H. H. Turner expressed the same opinion and declared that he knew of no scheme more deserving of government support than is the exploration of the upper air by means of kites.

Professor Hildebrandsson announced that the discussion of the cloud observations which had been made simultaneously in various parts of the world indicated the following to be the circulation of the atmosphere at different heights: (1) Above the thermic equator and the equa-

torial calms there exists throughout the year a current from the east; (2) above the trades an anti-trade blows from the southwest in the northern hemisphere and from the northwest in the southern; (3) this anti-trade does not pass the polar limits of the trades, but deviates more and more to the right in the northern hemisphere and to the left in the southern, so as to become a current from the west over the barometric maximum of the tropics where it descends to increase the trade; (4) the regions situated at the equatorial limit of the trade join sometimes that of the trade, sometimes that of the equatorial calms, according to the season; (5) the pressure of the air diminishes gradually towards the poles, at least beyond the polar circles; (6) the upper layer of air in the temperate zones flows over the high pressures of the tropics and descends there; (7) the irregularities found at the surface of the earth, especially in the regions of the Asiatic monsoons, generally disappear at the height of the lower or intermediate clouds; (8) it is necessary to abandon completely the idea of a vertical circulation between tropics and poles, hitherto assumed, according to James Thomson and Ferrel.

In the report of the Seismological Commission, presented by Mr. J. Milne, it was inferred from the data collected that the crust of the earth was not more than forty miles thick, the interior having a very high effective rigidity and the nucleus being probably more uniform in its chemical and physical conditions than was usually supposed. The report of the Ben Nevis Observatory Committee, drawn up and read by Dr. A. Buchan, stated that funds privately subscribed would maintain the high- and low-level stations for another year, after which time the permanent support of the government was desired. It was claimed that no pair of stations in the world are so advantageously situated for meteorological investigation and forecasting. Additional papers were by Dr. Buchan on the diurnal variation of temperature in the Levant and its relation to radiation; by Dr. Paulsen on a comparison of the spectrum of nitrogen with that of the aurora; by Dr. W. J. S. Lockyer on the spectra of lightning; by Dr. H. R. Mill on some rainfall problems; by Dr. L. A. Bauer on the magnetic survey of the United States and the earth's total magnetic energy, and by the writer on audibility at Blue Hill as affected by weather conditions.

Upon the recommendation of the council of the Physical Section, the General Committee of the Association passed a resolution that it is desirable to adopt a uniform system of units in meteorology, and another resolution to the effect that the systematic investigation of the upper atmosphere by means of kites and balloons is of great importance. A further appropriation of £50 was voted to Mr. Dines for the continuation of this work with kites.

In conjunction with the meeting of the International Committee, an exhibition of meteorological apparatus, charts and photographs was organized by the Meteorological Office and Society. Many pieces of new apparatus, as well as articles of historic interest, were shown and their study was facilitated by a carefully-prepared descriptive catalogue. The meteorological telegrams received each morning at the London office were repeated to Southport, where they were charted and forecasts made by a member of the staff. These were incorporated in a weather map that was printed and distributed during the afternoon and its close agreement with the map prepared in London from the same data was surprising. It had been announced that Mr. Dines would fly his kites from a steamer at South-

port, but, unfortunately, neither the boat nor the apparatus could be brought from Scotland in time for the experiments. Professor Pernter demonstrated the formation of vortex-rings on a large scale in the open air by firing a conical cannon, such as is used in some parts of Europe to disperse hail-storms. While the efficacy of the process is doubtful, yet in the Southport experiments the smoke-rings issuing from the cannon, which was placed horizontally instead of vertically, could be both seen and heard in their passage through the air for a distance of several hundred feet.

A visit was paid by the International Committee to the Fernley Observatory in Hesketh Park, established by Mr. J. Baxendell, Sr., and now maintained by the borough of Southport. This observatory, which is one of the best equipped in Great Britain, has an auxiliary station, provided with Mr. Dines' anemometers, situated near the coast. Excursions were made to the Stonyhurst College Observatory, near Whalley, Lancashire, and also to the Physical Laboratory of the Owens College in Manchester. About sixty meteorologists sat down to their annual breakfast, in accordance with a custom inaugurated some thirty years ago. The meeting terminated on September 16 with a brilliant banquet to more than one hundred persons, which was given by the mayor of Southport, Mr. Scarisbrick, at his residence, Greaves Hall, in honor of Sir Norman Lockyer, president of the British Association and Professor Mascart, president of the International Meteorological Committee.

A. Lawrence Rotch.

Blue Hill Meteorological Observatory,
October 30, 1903.

SCIENTIFIC BOOKS.

Manual of Advanced Optics. By C. Rigborg Mann. Chicago, Scott, Forsemann & Co. 1902. Pp. 193.

As the author states in the preface, this manual is the basis of the advanced laboratory course in optics in the University of Chicago, and represents contributions from various instructors. Naturally, it deals rather extensively with interference and the applications of interference methods.

The opening chapter presents, in a very simple manner, the important but generally neglected theory of the limit of resolution of a telescope. Chapter II. extends this theory to the case of two slit apertures before a lens for both single and double line sources. The experimental illustrations make clear the possibility of measuring the angular size of a source and the angular distance between two line sources, but do not suggest the application of this method to astronomical problems. Reference is not made to Rayleigh's theory of, and experiments with, the central stop. The third chapter, on Fresnel's mirrors, contains diagrams, familiar to all of Professor Michelson's students, illustrating the evolution from the earlier forms of interference apparatus to the modern interferometer. The theory and experiments in this chapter and in the following one on Fresnel's biprism take up seventeen pages of the text, relatively a large part when the grating is treated in eight pages.

Chapters V. and VI. contain Michelson's theory of the interferometer and its elegant applications. The presentation is very clear and the contents complete. The gathering together of material from little-used sources bearing upon the interferometer method, probably the most powerful and yet simple method we know in accurate measurement, makes this manual a valuable one to place in the hands of a student.

The arrangement of the material in Chapters VI. and VII. is out of the ordinary. For in the earlier chapter the author deals with a very modern, complex, perhaps forced, method of analyzing an approximately homogeneous radiation, while in the later chapter he presents the well-known prism method of analyzing a spectrum. The theory of Chapter VII. follows the methods of geometrical optics. Rayleigh's simple method of obtaining the dispersive power of a prism is not given.

The chapters on the plain and concave gratings, considering the space given to other parts of the subject, might have been fuller. The next six chapters contain theory and experiments on polarized light, the rotation of the plane of polarization, the laws of reflection from transparent and metallic surfaces and the spectrophotometer.

Two statements seem to be misleading. On page 90 it is stated that 'the slit in a spectrometer is made infinitely narrow by placing it at an infinite distance by means of a lens.' The meaning, of course, is that the divergence of the rays falling on the prism from one point of the slit is made very small by placing it at the focus of a lens. The angular width of the slit is finite, being equal to the width of the slit divided by the focal length of the lens. Again on page 159 it is stated that 'Ordinary photometers * * * may be used to compare the intensities of the total radiations of two sources.' Authors of texts can not be too careful to point out that the luminous part of the radiations are but a small part of the total energy sent out by a source. Indeed, it is to be regretted that the subject of optics is generally viewed in this limited light, that no mention is made of the instruments, bolometers, radiometers, thermoelements, etc., used in measuring the total energy of sources, and no notice taken of the interesting properties of bodies with regard to radiations other than luminous.

These general criticisms have no large value concerning the special purpose for which the book was prepared. As a manual of advanced optics it is admirable. G. F. Hull.

Dartmouth College.

SCIENTIFIC JOURNALS AND ARTICLES.

The October number of *The American Journal of Anatomy* contains the following articles:

Joseph Marshall Flint: 'The Angiology, Angeogenesis, and Organogenesis of the Submaxillary Gland.'

Richard Mills Pearce: 'The Development of the Islands of Langerhans in the Human Embryo.'

Robert W. Lovett: 'A Contribution to the Study of the Mechanics of the Spine.'

J. Playfair McMurrich: 'The Phylogeny of the Palmar Musculature.'

Bird-Lore for September–October contains articles on 'The Mystery of the Black-billed Cuckoo,' by Gerald H. Thayer, showing that it is a bird of nocturnal habits; on 'A North Dakota Slough,' by A. C. Bent; 'A Tragedy in Nature,' by William Brewster; 'Nesting Habits of Two Flycatchers at Lake Tahoe,' by Anna Head, and on 'How Birds Molt,' by Jonathan Dwight, Jr., one of the best authorities on this much-mooted subject. There is the sixth series of portraits of *Bird-Lore's* advisory councilors and numerous notes, including an interesting article on 'Mortality among Birds in June,' besides book reviews and the reports of the Audubon Societies.

The *Museums Journal* of Great Britain for September contains the address of the president of the Museums Association, F. A. Bather, delivered at the Aberdeen meeting of the association and devoted mainly to the subject of the better arrangement of art museums. A plea is made for smaller exhibition halls and the display of a comparatively small number of objects amid harmonious surroundings. Among the notes is announced the coming extension of the British Museum (the older building) at a cost of £200,000, and the coming publication of the first volume of a catalogue of the books, manuscripts and maps in the possession of the British Museum, of natural history.

SOCIETIES AND ACADEMIES.

AMERICAN PHYSICAL SOCIETY.

The fall meeting of the Physical Society was held at Columbia University on Saturday, October 31. The meeting was well attended and was marked by discussions considerably more extended than have recently been usual at Physical Society meetings. These discussions add so greatly to the interest of such gatherings that the further development of this feature of the meetings is much to be desired.

It was decided to hold the next meeting of the Physical Society in St. Louis during convocation week in connection with the Amer-

ican Association for the Advancement of Science. Since the Physical Society has been one of the affiliated societies of the American Association ever since its organization, this action was to be expected. It is hoped that this meeting of the society in the west will afford an opportunity for some organization there which will bring the same advantages to the physicists of the middle west which the meetings in New York have brought to those in the east.

The first paper, by Dr. P. G. Nutting, was upon the 'Distribution of Motion in a Conducting Gas.' In the experiments described in this paper Dr. Nutting used a thermopile in the form of a thin flat disk. This could be mounted in a vacuum tube in such a way as to present either its flat surface or its edge to the direction of the discharge. At low pressures the temperature indications were quite different in the two cases, since in one case the full bombardment due to moving ions and kathode rays was received on the surface of the pile, while in the other case only the movement across the line of discharge was effective in heating.

A paper on a special type of radioactivity was next presented by Miss Fanny C. Gates. This paper dealt with a peculiarity in the behavior of sulphate of quinine when heated to about 180° C. and then allowed to cool. During the process of cooling the quinine is found to make the air near it conducting; in fact, at first glance the quinine seems to behave for a while much like a radioactive substance. There are strong reasons for believing that the phenomenon is due to some relatively simple chemical change in the quinine, and the case has been cited as an argument in favor of explaining all cases of radioactivity by recognized types of chemical change. Miss Gates finds, however, that the effect produced by quinine obeys entirely different laws from the similar effect produced by radioactive substances. Experimenting with different electromotive forces and with different distances between plates, she found it impossible to produce saturation in the current due to the ionization by quinine. Even with plates only 3 mm. apart at a potential difference of 900 volts no indication of saturation could be observed. Assuming the ionization to be produced by rays emitted by the quinine it was found that these rays are completely absorbed by a thickness of aluminium which would scarcely affect the radiation from radium or uranium by a noticeable amount. The conclusion reached by Miss Gates is that the phenomenon is entirely different from ordinary radioactivity. She inclines to the view that the ionization is due to rays of ultra-violet light produced by the chemical change and absorbed in the immediate neighborhood of the surface.

A short paper by Mr. W. J. Hammer dealt with certain points connected with excited radioactivity. Mr. Hammer mentioned certain experiments which led him to believe that excited radioactivity was more permanent than is generally supposed, and that while it dies out rapidly at first, it finally reaches a nearly permanent value. Mr. Hammer exhibited numerous radiographs taken by himself and referred briefly to experiments by which animals had been killed by action of Becquerel rays. He also suggested the internal use of radioactive substances in the treatment of disease, in instances where it is impracticable to reach the seat of trouble from without. The active rays might be brought to the diseased parts by the use of solutions of radioactive substances or solutions which have been given excited activity.

In a paper on Van der Waals' *a* in alcohol and ether Professor E. H. Hall stated the result of calculations intended to test the validity of certain assumptions connected with the well-known Van der Waals equation. The character of the paper is such as to make it difficult to present the results in a brief abstract.

In the afternoon session W. S. Franklin spoke on the 'Misuse of Physics by Biologists and Engineers.' The object of the paper was to call attention to certain misconceptions of fundamental matters in the subject of thermodynamics which are common among engineers and biologists who have occasion to make applications of physics in their work. Pro-

fessor Franklin's paper led to a discussion of considerable interest.

Dr. Bergen Davis exhibited, in operation, his apparatus in which mechanical rotation is produced by the electrodeless discharge. It will be remembered that the apparatus consists of a little anemometer mounted at the center of a vacuum tube. The discharge in the tube is produced by an oscillating current in a surrounding coil. The motion of the ions constituting this current then produces rotation in the anemometer.

In a second paper by Dr. Davis the theory of 'The Electrodeless Discharge' was considered, the discussion being based upon experiments made upon carbonic acid and helium. It was found that the results in these experiments could be explained upon the assumption that ionization was produced by the impact of ions, these being always present to some extent. The theory developed enabled the mean free path of the ions to be computed. It was found to be 4.4 times the mean free path of the molecules. The result agrees very well with the value 4.3 obtained by J. J. Thomson by entirely different methods. Similar computation showed that an ion must move through a potential of 2.5 volts in order to ionize air. By different methods J. J. Thomson has found about five volts for this same quantity, the agreement in this case being, therefore, less satisfactory.

ERNEST MERRITT,
Secretary.

AMERICAN MATHEMATICAL SOCIETY.

A REGULAR meeting of the American Mathematical Society was held at Columbia University on Saturday, October 31. The attendance at the two sessions numbered about fifty persons, including nearly forty members of the society. The president of the society, Professor Thomas S. Fiske, occupied the chair. The following persons were elected to membership: Miss Grace C. Alden, Westfield, Mass.; Mr. L. D. Ames, University of Missouri; Professor R. C. Archibald, Ladies' College, Sackville, N. B.; Mr. W. H. Bates, Purdue University; Miss Harriet D. Buckingham, Lexington, Mass.; Miss Louise D. Cummings, Vassar College; Mr. Harry English, Washington, D. C.; Professor G. A. Gibson, Glasgow, Scotland; Miss Mary F. Gould, Everett, Mass.; Dr. O. D. Kellogg, Princeton University; Mr. W. A. Manning, Stanford University; Dr. C. M. Mason, Massachusetts Institute of Technology; Professor Helen A. Merrill, Wellesley College; Mr. E. A. Miller, Massachusetts Institute of Technology; Mr. E. H. Taylor, State Normal School, Charleston, Ill.; Professor Anna L. Van Benschoten, Wells College; Mr. R. E. Wilson, Northwestern University. Nine applications for membership were received. The total membership of the society is now 448, a gain of 48 since January last.

The office of assistant secretary of the society was revived and filled by the appointment of Dr. William Findlay, of Columbia University. A list of nominations for officers and members of the council was prepared and ordered placed on the official ballot for the election which takes place at the annual meeting in December. A committee was appointed to make arrangements for holding the next summer meeting of the society at St. Louis and to cooperate with the committee of the exposition in organizing the mathematical section of the international congresses.

The publication by the society of the courses of lectures delivered at the Boston colloquium by Professors Van Vleck, White and Woods is under consideration. While the society regularly publishes two journals, it could render still greater service to mathematics in several directions if even a small publication fund were at its disposal, its present income from membership dues being barely sufficient to meet its regular outlay in this direction. In view of the great work which the society has accomplished, chiefly at its own expense, it is to be hoped that it may soon receive a modest endowment to enable it to meet its increasing opportunities in a more effective manner.

The following papers were read at the October meeting:

A. S. GALE: 'On three types of surfaces of the third order regarded as double surfaces of translation.'

L. P. EISENHART: 'Surface of Bonnet and their transformations.'

EDWARD KASNER: 'On partial geodesic representation.'

F. N. COLE: 'On the factoring of large numbers.'

E. GOURSAT: 'A simple proof of a theorem in calculus of variations (extract from a letter to W. F. Osgood).'

BURKE SMITH: 'On the deformation of surfaces whose parametric lines form a conjugate system.'

G. A. MILLER: 'On the number of sets of conjugate subgroups.'

ELIJAH SWIFT: 'On the condition that a point transformation of the plane be a projective transformation.'

IDA M. SCHOTTENFELS: 'On the simple groups of order 8!/2 (preliminary communication).'

IDA M. SCHOTTENFELS: 'The necessary condition that two linear homogeneous differential equations shall have common integrals.'

The American Physical Society was also in session at Columbia University on the same day. The members of the two societies lunched together at the university restaurant. In the evening the members of the Mathematical Society held an informal dinner.

THE annual meeting of the American Mathematical Society will be held at Columbia University, December 28–29. The Chicago section of the society will meet, in conjunction with Section A of the American Association for the Advancement of Science, at St. Louis, December 31–January 1. F. N. COLE,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE ST. LOUIS CONGRESS OF ARTS AND SCIENCE.

TO THE EDITOR OF SCIENCE: In the number of SCIENCE for August 28, I occupied considerable space in raising certain questions suggested by Dr. Münsterberg's article on the St. Louis Congress in the May number of the *Atlantic Monthly*. I objected

1. To Dr. Münsterberg's basing the working classification and grouping of the schedule or program of that Congress upon a scheme of philosophical methodology (of which he himself happened to be the author), and

2. To the representation made in the article that the Committee on the Congress had given his methodology an official sanction and endorsement by arranging a program upon its basis.

In what purports to be a reply in SCIENCE for October 30, Dr. Münsterberg elaborately ignores the objection I raised and as elaborately attributes and refutes a position which I neither took nor even suggested. The objection which he attributes to me is upon its face either a matter of minor importance or else is absurd. This is an objection to the actual working classification and grouping adopted for the conduct of the Congress. It does not require two pages of SCIENCE to point out that such an objection is trivial if taken to mean an objection to just this or that number and set of divisions, departments and sections; and absurd if taken to mean objection to any classification and grouping whatsoever. Nor does it require a careful reading of my SCIENCE article to discover that I never entertained such objections.

While I regret that Dr. Münsterberg has raised an irrelevant issue, instead of discussing the matter on its merits, I yet take one consolation from his article. His ignoring the real point of my objection suggests that as a matter of fact the philosophical methodology set forth in such a prominent way in the May *Atlantic* has ceased to have (if it ever had) any bearing upon the actual conduct of the Congress; and that what now exists is just a certain working classification, whose exact merits, as I have just indicated, are a matter of detail and not of principle. In that case, while some explanation would seem to be due the editor and readers of the *Atlantic Monthly*, the scientific men of the country may rest reasonably content.

JOHN DEWEY.

THE UNIVERSITY OF CHICAGO.

RECENT ZOOPALEONTOLOGY.

ADDITIONAL DISCOVERIES IN EGYPT.

Cetacea.—Dr. E. Stromer describes a skull and lower jaw of a new species of *Zeuglodon*, *Z. Osiris*, from the Middle Eocene of Egypt,

and discusses in detail in two papers* and in an elaborate memoir† the structure and relationships of these animals. He advocates their extremely early origin, holding that even the oldest Creodonta do not give us a sufficiently generalized ancestor, and that we must revert to the Jurassic triconodont animals generally considered as primitive marsupials. The memoir is the most important and exhaustive one which has appeared upon the skull of this aberrant form.

Proboscidea.—Dr. C. W. Andrews‡ continues his important papers on the evolution of the Proboscidea, tracing this line back to *Palæomastodon,* Upper Eocene, and *Mœritherium,* Middle Eocene, a small ungulate with quadritubercular molar teeth, which this author regards as in the direct line leading to the Proboscidea; it shows most interesting relationships to the Sirenia, which tend to connect the two groups.

In this connection may be mentioned a paper by Mr. W. K. Gregory on the 'Adaptive Significance of the Shortening of the Elephant's Skull,'§ in which the mechanical effect of trunk and tusks on the evolution of the skull is worked out in detail.

Other Mammals.—Other African fossils described by Dr. C. W. Andrews‖ include the *Arsinoitherium,* a large ungulate with a pair of enormous horns on the front part of the skull, and a new hyracoid, *Saghatherium.* In this connection it is noted that 'the presence of five Hyraces in these beds indicates that these animals must at that time have been an important factor in the fauna, and that the comparatively small members of the group now existing are the degenerate descendants of a once important stock.' It is shown that the specialization of the molar teeth in the Hyracoidea was already well marked in the Upper Eocene beds. Of great interest also is the discovery of a large creodont referred to *Pterodon africanus,* of Oligocene age, and of an animal related to *Hyopotamus.* Altogether, the discoveries of Messrs. Beadnell, of the Egyptian Survey, and Andrews, of the British Museum, are the most important features of recent progress in mammalian paleontology.

Of an entirely different nature is the superb memoir entitled 'La Faune Momifiée de l'Ancienne Égypte,' by Messrs. Lortet and Gaillard, recently issued from Lyons. It covers the mummified mammals, birds and fishes of Egypt and includes an exhaustive systematic revision of these types, which have been known over a century but have never hitherto received adequate systematic description.

RECENT DISCOVERIES IN FRANCE.

Lophiodonts.—Professor Ch. Depéret, of Lyons,* has made the welcome discovery of the hitherto unknown skull of *Lophiodon* in the Middle Eocene, *Bartonien* age. He points out that it presents an astonishing resemblance to the skull of the primitive rhinoceroses, while it is remote from the skull of the tapirs. This resemblance agrees with the lophiodont form of the molar teeth, which is substantially intermediate between the tapir and the rhinoceros type.

Creodonts.—Equally welcome is the de-

*'Einiges über Bau und Stellung der Zeuglodonten, Sonder-Abdr. a. d. Mai-Protokoll,' *Zeitschr. d. Deutsch. geol. Gesellschaft,* Jahrg., 1903.

'Bericht über eine von den Privatdozenten Dr. Max Blanckenhorn und Dr. Ernst Stromer von Reichenbach ausgeführte Reise nach Aegypten. Einleitung und ein Schädel und Unterkiefer von Zeuglodon Osiris Dames,' Sep.-Abdr. a. d. *Sitzungsberichten d. mathem.-phys. Classe d. kgl. bayer. Akademie d. Wissenschaften,* Bd. XXXII., 1902, Heft III.

† 'Zeuglodon-Reste aus dem Oberen Mitteleochän des Fajûm,' Sep.-Abdr. aus *Beiträge zur Paläontologie und Geologie Osterreich-Ungarns und des Orients,* Band xv., Heft ii. u. iii., Vienna and Leipzig, 1903.

‡ 'On the Evolution of the Proboscidea,' *Proc. Roy. Soc.,* Vol. 71, p. 443.

§ *Bull. Amer. Mus. Nat. Hist.,* Vol. XIX., July 8, 1903, Art. IX., pp. 387–394.

‖ 'Notes on an Expedition to the Fayûm, Egypt, with Descriptions of Some New Mammals,' *Geol. Mag.,* Dec. iv., Vol. X., No. 470, August, 1903.

* 'Sur les caractères crâniens et les affinités des *Lophiodon,*' Ch. Depéret, Extr. des *Comptes Rendus des Séances de l'Académie des Sciences,* t. CXXXIV., p. 1278, 2 June, 1902.

scription by M. Marcellin Boule* (who has now succeeded Professor Gaudry as professor of paleontology in the Natural History Museum of Paris) of a large example of the Lower Eocene creodont *Pachyœna* of the family Mesonychidæ. This is the second example of this family found in France, and it strengthens the proofs of the close relation which existed between northern Europe and North America in the Lower Eocene period. The animal is slightly larger than the *Dissacus saurognathus* of Wortman.

Lower Oligocene Fauna.—Under the title 'Les Vertébrés Oligocènes de Pyrimont-Challonges (Savoie)'† MM. Depéret and H. Douxami contribute an extensive memoir of ninety pages on the Lower Oligocene of Savoy. The rhinoceroses are represented by a new type, *R. asphaltense,* which the authors consider allied to the American *Diceratherium.* It is characterized by a very long skull; the nasals, although separate distally, bear a rudimentary pair of terminal horns; the forefoot retains a reduced fifth digit, whereas the American forms are strictly tridactyl. It is shown that the classic *R. minutus* of Cuvier is exclusively Oligocene. A new genus of tapir, *Paratapirus,* is also described, in which the internal lobes of the superior molars are completely separated. The memoir concludes with a valuable review of localities where a contemporaneous fauna is found in various parts of France.

SOUTH AMERICAN MAMMALS.

Glyptodonts.—Professor Henry F. Osborn has recently described the complete carapace of a new genus of glyptodont, *Glyptotherium,* discovered in Texas by one of the Whitney expeditions under Mr. Gidley. It presents a curious combination of primitive and progressive characters.

Mr. Barnum Brown describes‡ a new genus and species of primitive glyptodont, *Eucinepeltus complicatus,* found on the Rio Gallegos by the American Museum of Natural History expedition of 1898. It is distinguished by the structure of the teeth and by the pitting of the plates on the cephalic shield, characters which are illustrated by a number of figures.

Armadillos.—The 'Reports of the Princeton University Expeditions to Patagonia, 1896–1899, in charge of J. B. Hatcher,' are now appearing rapidly under the editorship of Professor William B. Scott. Volume 5 opens with Part I., No. I., of Scott's Memoir entitled 'Mammalia of the Santa Cruz Beds,' and is devoted to the Dasypoda or armadillos of the Santa Cruz, which are fully described, and richly illustrated in sixteen plates. It is impossible to do justice to this very important memoir, which contains not only much needed systematic revision, but the enunciation of many important biological principles and full anatomical descriptions. The Edentata are regarded as a separate subclass divided into the armadillos, glyptodonts, ground sloths, tree sloths, anteaters, pangolins and aard varks. The Santa Cruz armadillos, as a whole, are very unlike the modern representatives of the suborder, rarely appearing ancestral to existing forms; it is certainly rather disappointing not to find any direct forerunners of the existing South American types. The author concludes that the lines of evolution which ended in recent genera must have taken place in some other region of the South American continent, doubtless the same region as that which gave rise to the true sloths and the anteaters, no trace of the latter two types having yet been found in the Santa Cruz beds. The usual systematic treatment is rendered difficult by the extraordinary variability of these animals. Most of them are of relatively small size. Although of great geological age, fully developed carapaces are found in both the armadillos and glyptodonts. The teeth are devoid of enamel, rootless and tubular, no traces of milk dentition having been observed. Altogether, they present a high degree of specialization, and in some instances, as in the reduction of the dentition in *Stego-*

* 'Le *Pachyœna* de Vaugirard,' *Memoires de la Société Géol. de France,* No. 28, Tome X., fascicule 4.

† 'Mémoires de la Société Paléontologique Suisse,' Vol. XXIX., 1902.

‡ 'A New Species of Fossil Edentate from the Santa Cruz Formation of Patagonia.' *Bull. Amer. Mus. Nat. Hist.,* Vol. XIX., 1903, pp. 453–457.

therium, they are more specialized than any recent armadillos.

MARSUPIALS AND MONOTREMES.

Professor C. F. W. McClure* contributes an exhaustive paper on the venous system of *Didelphys,* based on the examination of very extensive material which shows wide individual variation, partly reversional. In general, the venous system runs back through the monotreme to the sauropsidan or reptilian type, and exhibits profound differences from the venous system of the Placentalia.

Dr. B. Arthur Bensley† contributes a valuable paper in which he demonstrates that the groove on the inner side of the jaw of the Jurassic mammalia erroneously described by Owen and Osborn as a 'mylohyoid groove' is actually a 'meckelian groove,' lodging the Meckelian cartilage. After very extensive comparison of this groove in various types of mammals, he finds it frequently present in the Marsupialia, Edentata and certain Insectivora and Cetacea. It is, however, absent in the Multituberculata; the groove is also wanting in the Echidna, owing perhaps to the degeneration or reduction of the jaw. The paper is fully illustrated.

HORSES AND MAN.

A most interesting recent contribution to the *Comptes Rendus des Séances de l'Académie des Sciences* is by Emile Rivière‡ on the prehistoric figures of horses in the cave de La Mouthe found with figures of the reindeer, antelope, bison, buffalo, mammoth. Although for the most part crude outlines, they all possess a certain artistic value.§ H. F. O.

* 'A Contribution to the Anatomy and Development of the Venous System of *Didelphys marsupialis* (L.),' Part I., Anatomy, *Amer. Jour. Anat.,* Vol. II., No. 3, July 1, 1903, pp. 371–404.

† 'On the Identification of Meckelian and Mylohyoid Grooves in the Jaws of Mesozoic and Recent Mammalia,' *University of Toronto Studies,* No. 3.

‡ 'Les figurations préhistoriques de la grotte de La Mouthe (Dordogne),' *Comptes Rendus des Séances de l'Académie des Sciences,* 28 July, 1902.

§ 'Les Parois gravées et peintes de la Grotte de La Mouthe (Dordogne),' Extr. de 'l'Homme préhistorique,' t. I., fasc. 3, 1903.

THE ENDOWMENT OF APPLIED SCIENCE AT HARVARD UNIVERSITY.

By the will of the late Gordon McKay, of Newport, R. I., inventor of the sewing machine that bears his name, Harvard University receives a very large bequest for applied science, estimated by the daily papers to be 'about $4,000,000 and eventually many millions more.' According to the terms of the will, Harvard University is to receive $1,000,000 when this amount has accumulated from the income, and is thereafter to receive 80 per cent. of the balance of the income after annuities have been paid, and is to receive the entire residue of the estate after the death of the last surviving annuitant.

The portion of the will defining the object of the bequest is as follows:

The net income of said endowment shall be used to promote applied science.

First, by maintaining professorships, workshops, laboratories and collections for any or all of those scientific subjects which have, or may hereafter have, applications useful to man; and

Second, by aiding meritorious and needy students in pursuing those subjects.

Inasmuch as a large part of my life has been devoted to the study and invention of machinery, I instruct the president and fellows to take special care that the great subject of mechanical engineering, in all its branches and in the most comprehensive sense, be thoroughly provided for from my endowment.

I direct that the president and fellows be free to provide from the endowment all grades of instruction in applied science, from the lowest to the highest, and that the instruction provided be kept accessible to pupils who have had no other opportunities of previous education than those which the free public schools afford.

I direct that the salaries attached to the professorships maintained from the endowment be kept liberal, generation after generation, according to the standards of each successive generation, to the end that these professorships may always be attractive to able men and that their effect may be to raise, in

some judicious measure, the general scale of compensation for the teachers of the university.

I direct that the professors supported from this endowment be provided with suitable assistance in their several departments, by the appointment of instructors of lower grades, and of draughtsmen, foremen, mechanics, clerks or assistants, as occasion may require, my desire being that the professors be free to devote themselves to whatever part of the teaching requires the greatest skill and largest experience, and to the advancement of their several subjects.

I direct that the president and fellows be free to erect buildings for the purposes of this endowment, and to purchase sites for the same, but only from the income of the endowment.

I direct that all the equipment required to illustrate teaching or to give students opportunity to practice, whether instruments, diagrams, tools, machines or apparatus, be always kept of the best design and quality, so that no antiquated, superseded, or unserviceable implement or machinery shall ever be retained in the lecture-rooms, workshops or laboratories maintained from the endowment.

Finally, I request that the name Gordon McKay be permanently attached to the professorships, buildings and scholarships or other aids for needy students, which may be established, erected or maintained from the income of this endowment.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND AFFILIATED SOCIETIES.

THE American Association for the Advancement of Science will meet at St. Louis during convocation week, beginning on December 28, 1903, under the presidency of the Hon. Carroll D. Wright, U. S. commissioner of labor and president of Clark College. We hope to publish shortly full details in regard to the meeting and the local arrangements.

THE American Society of Naturalists will meet at St. Louis during convocation week. The exercises will consist as usual of a lecture followed by a smoker, a business meeting and a discussion on Wednesday afternoon, and a dinner in the evening followed by the address of the president, professor William Trelease, director of the Missouri Botanical Garden.

THE sixteenth winter meeting of the Geological Society of America will be held at St. Louis, Mo., probably in a parlor of the Planters Hotel. The meeting will be called to order by President S. F. Emmons at 10 o'clock A.M., on Wednesday, December 30. The meeting of the Cordilleran Section will be held January 1 and 2, 1904, in the Academy of Sciences, San Francisco.

THE American Chemical Society will meet in St. Louis on December 28 and 29. The headquarters will be the Southern Hotel, and the meeting place will be the Central High School Building. The retiring address of the President, Dr. John H. Long, will be given, probably, on Wednesday evening at 7:30. Subject: 'Some Problems in Fermentation.'

THE American Psychological Association will meet at St. Louis on Tuesday and Wednesday of convocation week under the presidency of Dr. W. L. Bryan, president of the University of Indiana.

THE next meeting of the American Philosophical Association will be held at Princeton, N. J., on December 29 and following days. The hospitalities of the meeting and program are also extended to those members of the American Psychological Association who do not meet with their own association in St. Louis.

WE hope to publish next week official notices in regard to the other scientific societies meeting during convocation week.

SCIENTIFIC NOTES AND NEWS.

THE medical faculty of the University of Buffalo has invited Dr. Samuel J. Meltzer, of New York, to deliver the Harrington lectures for 1903. The subject selected by Dr. Meltzer is 'Edema, a consideration of the physiological and pathological factors concerned in its formation.' The lectures will be delivered in the Medical College, November 30, and December 1, 2 and 3, at 5 P.M.

Mr. Henry Rutgers Marshall, the architect of the library given by Mr. Ralph Voorhees to Rutgers College, and well known for his contributions to psychology, was given the degree of Doctor of Literature on the occasion of the dedication of the library.

Professor Hugo de Vries celebrated the twenty-fifth anniversary of his professorship in the University of Amsterdam on October 25, 1903. On this occasion he was presented with the sum of 4,250 Gulden by his colleagues and admirers in Holland, with the request that this sum be used in prosecuting further researches on mutation in plants. Cooperative experiments in this subject are being carried on in the New York Botanical Garden by Dr. D. T. MacDougal.

Arrangements have been made for a Sigma Xi dinner and address during convocation week at St. Louis. President D. S. Jordan will deliver the address before the society. The society now numbers more than two thousand members in the United States, and a large attendance is expected. Professor A. S. Langsdorf, of Washington University, is secretary of the committee on arrangements.

The Royal Scottish Geographical Society has bestowed honorary membership and its Livingstone gold medal on Commander Robert E. Peary, U.S.N.

It is reported, though perhaps on inadequate authority, that the Nobel prize in physics will be awarded to Mr. G. Marconi; in chemistry to Professor Arrhenius, and in medicine to Professor Finsen.

Professor von Zittel, of Munich, who met with a serious accident recently, is rapidly recovering and hopes to begin his winter semester lectures soon.

Dr. George T. Moore, of the United States Department of Agriculture, is spending a month in Dr. Winogradsky's laboratory at the Imperial Institute for Experimental Medicine, St. Petersburg. He is studying the various soil bacteria, especially those that fix atmospheric nitrogen, and the nitrite and nitrate organisms. Dr. Moore is conducting the investigations of soil bacteria being carried on in the Division of Pathology and Physiology of the Bureau of Plant Industry, and has already accomplished some important work in this field. He will probably not return to Washington before the middle of January.

Dr. E. B. Copeland, A.B. (Stanford, '95), who has been instructor in bionomics at Stanford University for the past two years, will sail this week for Manila to take up his work as chief botanist of the U. S. Philippine commission. Miss Mary Isabel McCracken, A.B. (Stanford, '03), will have charge of Dr. Copeland's work in bionomics.

Professor John W. Toumey, of the faculty of the Yale University Forest School, has been elected director of the Yale botanical garden.

Dr. G. P. Merrill, curator of geology at the U. S. National Museum, has returned from a visit to the petrified forests of Montana.

The daily papers state that Dr. W. G. Tight, president of the University of New Mexico, and Miss Annie S. Peck have returned after explorations in Peru. They failed to reach the summit of Mount Sorata, the highest summit in the Andes.

Professor C. F. Chandler, of Columbia University, gave a lecture before the American Philosophical Society on November 6, his subject being 'The Electro-chemical Industries of Niagara Falls.'

Professor R. E. Dodge, Teachers College, Columbia University, began on the twelfth instant a course of lectures on climate and mankind given at the American Museum of Natural History under the auspices of the Board of Education.

On October 2, the winter course of lectures before the American colony in Munich was opened by Professor Hartzell, his subject being 'Volcanic Phenomena.' He was followed by Professor Fullerton on the sixteenth and thirtieth, his subject being 'Psychic Phenomena.' It is proposed to have lectures on the first and third Fridays of each month during the winter.

Sir William White gave the presidential address before the British Institute of Civil Engineers on November 3.

Commander Robert E. Peary, U.S.N., lec-

tured before the Royal Geographical Society, London, on November 10. He is at present engaged in examining the naval barracks of foreign countries as a member of a commission recently appointed by President Roosevelt.

A MEMORIAL to Professor Joseph Le Conte, has been constructed by the Sierra Club of San Francisco in the Yosemite Valley at a cost of $8,000. It is a building of granite, erected under the walls of Glacier Point. The building is divided into three parts, the main room measuring 28 x 38 feet. Above the main room a Gothic roof rises to the height of thirty-five feet. Inside are a large reading table, wall seats and a large bookcase in which are kept books and papers pertaining to travel and research and maps and papers furnished by the Sierra Club.

THE library of the late Professor Virchow, containing seven thousand volumes has been presented by Mrs. Virchow to the Berlin Medical Society.

THE bronze shield subscribed for by the students of the British Institution of Electrical Engineers was placed on the tomb of Volta, at Camnago, Italy, near Como, on October 4. The shield is mounted on a slab of green marble supported on granite in front of the tomb.

THE position of paleontological draughtsman in the U. S. Geological Survey will be filled by civil service examination on December 8. The salary of this position is $840 or $900 a year.

A CONFERENCE of Eastern hydrographers, called by Mr. F. H. Newell, chief engineer of the hydrographic division of the Geological Survey, was held in Washington from October 28 to 31, inclusive. The following districts and divisions of the work were represented: New England, Mr. N. C. Grover; New York, Mr. Robert E. Horton; Central States, Mr. E. G. Paul; Southern States, Mr. M. R. Hall; Mississippi Valley States, Mr. E. Johnson, Jr.; general inspection, Mr. E. C. Murphy; Washington office, Messrs. G. B. Hollister and John C. Hoyt; hydro-economics, Mr. M. O. Leighton; hydrology, Mr. M. L. Fuller.

ACCORDING to a Reuter telegram from St. Petersburg, dated October 25, the search for Baron Toll, the missing explorer who set out on May 23, 1902, in company with the astronomer M. Seeberg and two Yakuts to explore Bennett Island and who has not been heard of since, still continues. M. Brousnieff, an engineer, who was sent to relieve Baron Toll, arrived in New Siberia with his expedition on March 11, but found nobody on the island. Five days later he set out across the ice in the direction of Bennett Island, but about 30 kilometers from the coast a stretch of open water at least five kilometers broad was encountered, and the expedition was obliged to turn back. No news has been received of the relief party under Lieutenant Koltchak, which was to have endeavored to reach Bennett Island by boat *via* New Siberia, and which was expected to reach its goal last June. There is hardly any prospect of further news being received either from the missing explorer or from the relief expeditions before December, as communication between the islands and the mainland will be interrupted until then.

THE Vienna Academy of Sciences has appointed a committee to study pitchblende, the mineral from which radium is derived. Baron Auer von Welsbach has placed his laboratories at the service of the committee during its researches.

THE Italian Congress of Pathology was held at Florence in October and appointed Milan as the place for the next meeting, which will be held during the spring of 1905. Professors Golgi and Foa were appointed a committee to confer with the German Pathological Society as to whether the approaching congress could be made international.

THE New Zealand Parliament has passed a bill empowering the Governor to introduce after January, 1906, the metric system, which is then to become the only system of weights and measures for the country.

COOPERATIVE arrangements have been made between the United States Geological Survey, through its Hydro-Economic Section, and Professor Chase Palmer, of the Central University of Kentucky, at Danville, for the maintenance of an extended series of chemical ex-

aminations of the water of the principal rivers in that state. This work is carried on under an act of congress authorizing the Geological Survey to determine and report upon the water supplies of the United States. Up to the present time comparatively little has been known either of the quantity and quality of Kentucky waters, or of their availability for use in domestic supply, especially in connection with the larger municipalities of the state. The plan which has recently been put into operation contemplates the periodical examination of the waters of Kentucky River at Jackson, Beattyville, Tyrone, Worthville, Irvine and Frankfort; of Green River at McKinney; of Dix River at Silver Springs and of Salt River at Salvisa. The work is carried on according to the standard methods adopted by the Geological Survey and the chemical profession generally throughout the country, and is under the immediate charge of Mr. M. O. Leighton, hydrographer in charge of the Hydro-economic Section.

UNIVERSITY AND EDUCATIONAL NEWS.

Under the will of Sarah B. Harrison, Yale University is given $100,000, in memory of her brother, the late Gov. Henry B. Harrison, of Connecticut, who for thirteen years was a member of the Yale corporation. The money is given in trust, the income to be used for such purposes as the university shall desire.

A collection of fresh water fishes from different parts of Siberia has recently been received by the Zoological Department of Stanford University. The collection consists of several hundred specimens, and was donated by Mr. James F. Abbott, '99, who is now at the University of Chicago.

The collections and library of the late Albert H. Chester, professor of mineralogy and geology at Rutgers College, have been donated to the institution by his son, Mr. A. H. Chester.

It is said that the medical school which was to have been opened at Constantinople on November 6 has been abandoned and that Professor R. Rieder, who was to have been director, has returned to Bonn.

The Council of the Senate of the University of Cambridge has issued an important recommendation at the instance of the chancellor. The Duke of Devonshire had called their attention to the expediency of modifying the requirements of the university in respect to classical languages and of enlarging the range of modern subjects. It had further frequently been urged upon the council that changes were necessary, owing to the reorganization of secondary education throughout the country and by recent developments in other universities. The council recommended the appointment of a syndicate, with extensive powers of inquiry and discussion, to consider what changes, if any, are desirable in the studies, teaching and examinations of the university.

The *Journal* of the American Medical Association states that the well-known 'Military Medical Academy' at St. Petersburg appropriates annually nearly $800 as a fund for professors in the academy who during the year have published works on their special branches of science. This year it was divided between Professors Bechtereff and Kravkoff, who published manuals respectively on the functions of the brain, and on pharmacology.

Dr. Herbert P. Johnson has been appointed associate professor of bacteriology in the Medical Department of St. Louis University, St. Louis, Mo.

Mr. Franklin D. Barker, formerly head of the Department of Natural Science in Ottawa University, Ottawa, Kans., has been appointed instructor in zoology at the University of Nebraska, Lincoln. He enters at once upon the duties of the new position.

Dr. Howard S. Anders, president of the Pennsylvania Society for the Prevention of Tuberculosis, and lecturer and clinical instructor in physical diagnosis in the Medico-Chirurgical College of Philadelphia, has been made an assistant professor of physical diagnosis in the latter institution.

Dr. Pompeckj, of Munich, has been advanced to professor extraordinary in paleontology and geology.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, NOVEMBER 27, 1903.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ST. LOUIS MEETING.

LOCAL arrangements have now been nearly completed for the St. Louis meetings, beginning with December 28 and running through convocation week. With the exception of the address of President Remsen, on Monday evening, for which the Odeon—a large hall near at hand—has been secured, and possibly one or two other public evening lectures, all the meetings will be held in the Central High School. This is a modern building with good internal arrangements. It is situated on Grand Avenue between Bell and Fimney Avenues, with convenient car service to the residence and business districts of the city. Ample rooms for all the sections of the American Association and for the affiliated societies are provided, and a suggestion made in SCIENCE early in the year has been acted on by furnishing each section with a lounging room, adjoining its meeting room. The officials of the board of education have cooperated with the principal of the school and the local committee in adapting the rooms to the purposes of the meeting by substitution of seats for desks in many rooms, and by the

provision of comfortable arm-chairs in the lounging rooms.

Hotel headquarters of the American Association and of several of the affiliating societies have been placed at the Southern Hotel; others will be at the Planters House, and still others, doubtless, in other down-town hotels—the disposition, apparently, being to centralize hotel headquarters, as the meeting places are centralized, even though but a part of the expected members can be accommodated in a single hotel at the holiday season when the hotels of a commercial city are most crowded because of the influx of traveling men who at other times are distributed over the country. The local committee, however, promises ample and good accommodations for the largest number who can attend the meetings, and have secured reasonable and in most cases reduced rates for the occasion.

The railroads promise the customary rate of one and one third fare for the round trip, from all parts of the country, on the certificate plan.

So far as can be judged from the information now in hand, the sections of the association and of the affiliating societies will have full and attractive programs, so arranged as to prevent the simultaneous presentation of papers interesting to the members of different organizations standing for similar divisions of sciences; and a little conference between the various secretaries and arrangement with the local secretary will readily ensure the entire absence of this disturbing feature of some meetings.

Sessions for the most part are limited to morning and afternoon hours, a lunch being provided in the school building by the local committee for every day but Thursday, when, after the noon adjournment, members will go to the exposition grounds, where they will be given a buffet luncheon by the exposition authorities and afterwards, in parties of convenient size, shown through the buildings by the chiefs of departments, under whom the exhibits are in process of installation. Not the least part of the interest in this afternoon will lie in the opportunity to inspect the magnificent new buildings of Washington University, which are to be occupied at the close of the exposition.

Some unusual degree of care has been taken to prevent a clash of interests in the evenings of the week, Monday evening being reserved for the address of the retiring president, Dr. Remsen, and the other evening events, so far as the local committee could adjust them, being placed with this end in view.

One advantage—or disadvantage—of meeting in convocation week is that the diversions and hospitalities incident to a meeting in the summer vacation are not possible. The local committee, however, has studied to provide for their scientific guests all the opportunities that can be utilized for seeing the interesting features of St. Louis and testing the hospitality of its citizens; and it is probable that the various secretaries will so adjust their programs as to make it possible for members to see what they care to see of the engineering, chemical, manufacturing and scientific sights of the city.

In the way of specific diversions, aside from the visit to the World's Fair, may be noted one or more evening lectures of general scientific interest, the annual dinners of the American Society of Naturalists and the Sigma Xi Honorary Scientific Society, each followed by an address by a prominent speaker, and the annual banquet of the trustees of the Missouri Botanical Garden, which is one of the notable events of the year, and for which personal invitations will be extended to as large a number of the distinguished guests of the city as can be provided for.

These statements should make clear that provision has been made for one of the most successful and one of the pleasantest meetings of the American Association for the Advancement of Science and the American Society of Naturalists, with the many organizations that meet in affiliation with them; and the members of the bodies that are to meet in St. Louis should at once put their respective secretaries in possession of titles and abstracts of the papers that they propose presenting, so that the detailed programs may be prepared in the best manner.

In addition to the sections of the association, all of which except Section K are to meet this winter, the following affiliated societies are to hold meetings in St. Louis during convocation week: The American Anthropological Association, The American Chemical Society, The American Mathematical Society—Chicago Section, The American Microscopical Society, The American Physical Society, The American Psychological Association, The American Society of Naturalists—and with it the Central Branch, The American Society of Zoologists—Central Branch. The Association of Economic Entomologists, The Association of Plant and Animal Breeders, The Astronomical and Astrophysical Society of America, The Botanical Society of America. The Central Botanists' Association, The Fern Chapters, The Geological Society of America, The Sigma Xi Honorary Scientific Society, The Society for Horticultural Science and The Society for the Promotion of Agricultural Science. The Botanical and Entomological Clubs of the association will also meet informally at times that will not conflict with the corresponding sections.

In our next issue the details of the arrangements for the meetings will be given, and the preliminary announcement, which will be mailed to members about the first of December, will contain full information as to hotels, railroad tickets, etc.

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*SCIENCE AND MEDICINE IN THE MODERN UNIVERSITY.**

BELIEVE me, it is a difficult thing for a stranger, even at your invitation, to address you on an occasion like the present. So many significant events crowd in upon him and time for reflection is needed to weld into a connected whole the impression he would wish to offer to you. Not that the growth and doings of this university have not been followed and watched with interest by us in the old country. On the contrary, your activity has been felt, not

* Address given at the formal opening of the new laboratory for physiology, pathology and medicine of the University of Toronto, on October 1, 1903.

only as a matter of mutual congratulation, but as a spur to arouse us to effort in our own similar pursuit of educational aims. But the stranger coming among you necessarily feels the shortcomings of his acquaintance with the details of these academic enterprises you have taken in hand. One advantage, however, is his. His view, gained from a distance, necessarily has freedom and truth of perspective that may give it a value in your eyes.

Some things lose by perspective. Some things, imposing when seen close to hand, dwindle when viewed from afar. Not so Canada. The perspective given by the width of the Atlantic is but an appropriate setting across which to view her greatness and her far-reaching activity. And this event, this academic celebration, this *dies festus,* in your university to-day, retains from afar off all the significance of a great event. It loses no tittle of its dignity and import when viewed across ocean from the crowded turrets of the older Cambridge, or the hoary spires of Oxford. It shines, I assure you, like a beacon to the new university whose buildings are as yet unfinished on the hill above the port of Liverpool.

Coming from a region where history is long and the land little to this where written history is short and the expanse of land incomparably great, one realizes how relative is size. And in regard to the event of to-day the largeness of this country rises in my thought not as a matter of mileage, but—that with you more than with us in the old country, the size of to-morrow is vaster than the size of to-day. Each step of progress here, more than with us, has to be measured by its ample consequences in a more rapidly widening horizon of the morrow. These new laboratories have a field already demanding them, and a still larger lies before them in an immediate and historic future.

Biology is the study of life in regard especially to growth and organization. Every medical man is a biologist, and as a biologist it may be but natural if I regard to-day's event from a biological standpoint, and the community as an organism, and the university as a living organ, essential to the healthy life of the community.

Science—especially medical science—is growing in importance to the community. We must have organization in science as in industry. This university to-day makes provisions of first-rate importance for the organization of medical and allied sciences in the region which centers here. Capacity to rear and support men constitutes the extent of a country, and population is the biological measure of the social organism. The ceaseless energy of the race has begun to plant a great population in this land. Growth, great and rapid, is inevitably before it. The growth of nations as of individuals requires the vigilance of guiding hands. Growth, for it to take its course rightly towards perfection, requires that provision for the security and expansion of the liberal arts and sciences forerun rather than halt behind the actual requirement of the hour. It is not only for their direct utilitarian service. They form a whetstone for man's most universal tool, his intellect, also a discipline for character, in the pursuit of truth for its own sake. Scientific truth, when found, has often proved unpalatable to man, as when it dethroned him from his fancied seat at the center of the whole perceptible universe, a universe he had imagined simply subservient to his needs; or again, as when it taught him that instead of being a creature altogether apart from the brutes, there are flesh and blood bonds between himself

and them. Regardless of its cost to his cherished fancies, man strives for scientific truth. And, as the old Greeks said, this purpose puts him further from the brutes and nearer to the gods.

In nurturing science I would urge that a community cultivates more than mere utility. And even with regard to mere utility, as the fields of knowledge fall ripe under the ceaseless husbandry of the world's thought, those who would join in the great reaping, and not only glean where others reaped before them, must cultivate for themselves. To do this requires more than the devotion of individuals. It requires the intelligent cooperation of whole groups of individuals. Organized scientific inquiry becomes in advanced countries a conscious aim of the community as a community.

That society may draw due benefit from wells of natural knowledge, three kinds of workers have to stand side by side. First, the investigator, who, pursuing truth, extends discovery, with little or no reference to practical ends. He constitutes the fountain-head of the knowledge that is for distribution. Other hands may reap the harvest, but his set and rear the seed.

After the investigator comes the teacher. To him it belongs to diffuse the knowledge won. This honorable and difficult task receives its best reward in seeing the small spiritual beginnings of a pupil widen into the spiritual beginnings of a master. Thirdly, there is the applier of natural knowledge. His part consists in making scientific knowledge directly serve practical needs. It is this work which to the popular idea often represents the whole of science, or all of it that is commonly termed 'useful.' The practical results of this work are often astounding to those ignorant of the steps by which they have been reached. The greatest of these steps, however, is usually the first one, made in the laboratory of the investigator. These three coworkers are coequal in the priesthood. Science and the applications of science are one growth, united together even as the fruit and the tree. The proper hearthstone round which the community should group these laborers, laboring for a common end, is the university. There the sacred flame of learning is fed from many sides by many hands.

It is sometimes said that pursuit of science renders a man deaf to the appeals of practical life. That it tends to withdraw him from the everyday interests of the people. That I do not believe of any science, certainly not of biology and the medical sciences. From their very outset these subjects draw the mind toward study of an organization the most complex and the most perfect it can examine. The ancient simile that our school classic, Livy, drew between the human body and the body politic, the state, has not lost but won significance as the centuries have run. The achievement of the microscope has been the discovery that living things, whether plant or animal —all living things of more than minutest size—are commonwealths of individually living units. These cells, as they are called, are living stones that build the house of life. In that house each stone is a self-centered individually living microcosm individually born, breathing for itself, feeding itself, consuming its own substance in its living, and capable of and destined for an individual death. Each cell lives by exchanging material with the world surrounding it. In other words, its bulk depends on its surface. Hence, surface increasing as the square and volume as the cube, cell-size is circumscribed by tiny limits—microscopic limits. Had the dependence been greater than it is, and the average size of the cell less, and too small for resolution

and discovery by the microscopes of seventy years ago, it is hard to imagine where biology would stand to-day. For two generations every biologist has been accustomed to think in terms of the cell theory. Every shred of the body he knows as an intricate interlacement, embodying cooperation and mutual support of associate thousands of individually existent cells. Division of labor has gone on, and with it differentiation of structure; while this group of cells combines with its own inner life some special function subservient to the needs of the great commonwealth as a whole, another group is specialized for another duty again subservient to the general needs. Each organism, however complete its solidarity, each one of ourselves here, is built up of living myriads. Each such organism consisted at its outset of but a single cell, and from that in his life's growth have arisen the countless myriads composing him to-day. The blood relationship is close between all the cells of each individual body. The cells of our nerves, of our muscles, of our lime-hardened bones are all blood relations through one common ancestor. Yet so far has specialization of these unit lives gone on, so far does function reflect itself in microscopic form, that there is greater likeness between my nerve-cells and the nerve-cells of a fish than between my nerve-cells and my own muscle-cells—despite the blood relationship between these latter. And in the commonwealth of cells that constitute each one of us, goes forward day long, night long, as in the body politic, the birth of new units to replace the ones outworn, the subordination of many individual purposes to one, the sacrifice and destruction of the individual life for the benefit of the many.

Trained in study of such an organism, surely the biologist and the medical man will be the last to underrate the importance of organization to the community for the common weal. Therefore I am rejoiced, but I am not surprised, that it is your faculty of medicine which to-day, in its public-spiritedness, erects and instals these fine laboratories, this potent addition to the organization of your community, for its activities in medicine and biological science. I would also, as a friend among you, offer you my congratulations on the consolidation of your two schools of medicine. Union means not only greater strength, but the more effective application of that strength.

I need not to this assembly extol medicine. Many of her votaries are here; I venture to count myself as one. But to-day the relation toward her of education is a matter on which our minds are naturally set. Am I wrong if in regard to this it rises saliently to me that from the educational standpoint medicine, like Janus of old, in a good sense, bears a double face? On the one hand, she is an empiric. She has learned to cure by what the comparative psychologist calls the 'method of trial and error.' Her conquests over sickness were acquired purely as result of experience, without help either from a priori or from inductive reasoning. And great and glorious is the rôle of her achievement on these lines. Of her humanitarian triumphs probably still—certainly until a generation ago—the greater share is assignable to this part. The use of quinine in malaria, the curative effects of the iodides and various metals, the discovery of chloroform and ether as anesthetics, these and the names of a long line of famous physicians from the renaissance down to some as justly famous as the past, and with us now to-day, suffice to certify the inestimable gifts that medicine as empiric has given to mankind in his suffering. This face of medicine may well wear a garland.

In her other aspect, medicine is not an empiric, but a scientist. Who will refute

me if I assert that medicine is as well as an art a science? Somewhere it is said that woman is the last thing that man will ever civilize. So the scientific aspect, the male face of two visaged medicine, thinks of that female face, the empiric, with whom his lot is linked. He feels sometimes that his other half is the last thing science will ever render wholly rational. By dint of patient toil he improves her practice by showing her a reason now and then. No sooner is that done than she is off on a fresh flight into the inexplicable, and he must cudgel his brains anew to find her a fresh logical position.

The feminine, ever youthful trait in medicine has to the student an undying charm. But, on the whole, the countenance of medicine has of recent years, for the student, become masculinely severe. This masculine head of medicine has indeed become the larger. Hydrocephalic in appearance though it may be, it is filled, not with water, but with reasoned facts. The development proceeds in the main from certain data acquired in the century just passed. For instance, the chemist, in discovering that all the million-sided chemical diversity of the perceptible universe is composed from a few—some seventy—substances, therefore called elemental, discovered also that living matter, instead of containing elements different from and subtler than those of the dead world, consists of just a few of the very commonest of those same ones. Further, the doctrine of the indestructibility of matter was demonstrated in a new form, namely, as the indestructibility of energy, and the convertibility of any one form of energy into other forms. Thus dead and living matter became united as subject material for study. It became really possible to consider the living body as a chemical and physical machine, a machine to which the laws of chemistry and physics can be applied.

But this scientific progress in medicine, fruitful of benefit to the community, lays on the community a burden of obligation. The empirical part of medicine is at once the most easy and the most difficult thing to teach. The preparation for learning it requires but little training in other subjects. Its facts lean on nothing but themselves.

With the scientific part of medicine it is different. That is based upon initiatory studies. Medicine, historically traced, we find first drawing help from the simplest and nearest at hand of these adjuvant studies. First she bent to the study of the gross form of the parts and organs of the body. The gross form of these is significant chiefly where they are machinery for application of mechanical powers. The greater part of the corporeal machinery is, however, not destined for such work, but has its purpose in processes chemical, thermal and electrical, to which—marvelous appendage—mentality is adjunct. Medicine in the course of the seventeenth and eighteenth centuries sucked dry for the most part what the study of the gross form of the body's parts could yield her. She then turned to the study of microscopic form—examined what Bichat first named the tissues, the fabric of the body. In so doing she came upon a great generalization, the cell doctrine, discovering an essential and visible similarity of microscopic structure in all that has life, differentiating it from all which has not life.

But even before the advent of the cell theory, medicine had begun to ask of chemistry what it could give her. With the discovery of oxygen and of the nature of combustion the links between biology and chemistry began to be tightly drawn. The young Oxford physician, Mayow, had performed the fundamental experiments on respiration and had discovered oxygen more than a century before Priestley and Lavoisier; but the time was not ripe until

the stupendous work of Lavoisier had founded modern chemistry. The cell theory was from the first not only morphological but physiological. It meant for the application of chemistry to biology that the chemistry of the body or of one of its organs was a chemistry resultant from a thousand tiny living furnaces, individual seats of oxidation, deoxidation, polymerization, hydrolysis and what not.

Not only that, but the living laboratory of the cell itself manufactures even the medium in which the cells themselves exist: the saps and juices of the body. And we are beginning to know, thanks to pathology, that every species of animal produces an internal medium specific to itself. Further, your distinguished physiologist here, Professor Macallum, who has so revealed the distribution of the chemical elements within the cell, tells us that the internal medium which the cells of even the highest animal forms produce as appropriate for themselves, still approximates in its salts to the water of the ancient geologic seas in which their ancestry arose, and still reveals in fact the composition of that ancient ocean. In that respect these living cells, with all their influx of change, have been more durable and constant even than ocean itself. The contrast brings home to us a deep distinction between dead matter and living—the latter a moving equilibrium, gaining stability from the very motion of itself.

By Schwann and by Pasteur the bonds between chemistry and medicine were drawn still tighter through discoveries concerning those subtle influences named 'ferments.' Pathology, the study of these processes of the body in disease, even more than physiology, as yet, has drawn help from this part of modern chemistry. If the processes of health are in fact the resultant of the due cooperation of ten million little foci of healthy chemical action in the body, the processes of disease are similarly divisible, and have to be traced to the unhealthiness of certain of these minute centers of activity. How extreme is the importance of chemistry to modern medicine, no single statement can perhaps emphasize so well as this—that is, I believe, acknowledged on all hands—that in virtue of his chemistry, a chemist, Louis Pasteur, during the latter half of last century, was able to do more to alleviate the diseases of mankind and animals than any physician of his time.

To the physicist also medicine has made appeal. From him she has got understanding of the body's heat, the basis of the knowledge of fever; she has learned the intricacies of the mechanism of the eye and refined methods of examining that organ and of remedying many of its defects; the laws that govern the circulation of the blood and the subtlest means of detecting the forces liberated in the working of the nervous system. In some cases, as sciences grow, their discoveries seem to sunder them the further one from another. In my belief, that merely shows they are then at the outset of their career. To-day we find physics and chemistry converging and conjoining within a field of physical chemistry. It early became convenient to have a specific name for living material, wherever found. The name given was protoplasm. It might have been better to call it x or y, so far was it in many respects an unknown quantity. Instead of looking forward upon this material as a chemical entity, we incline now to regard it rather as a field for chemical action satisfying certain particular conditions. Probably discoveries regarding these conditions will fall to the physical chemist, perhaps in a future very near at hand. Probably such discoveries will be among the most valuable that medicine has yet received from any source.

I have said enough to remind us how interlocked with science medicine has become. She is applying sciences to her own problems, and they form a vast capital fund from which she can draw wealth. To give instruction in this part of medicine, to turn out men trained in it, is now one of the duties of a medical school. The earnest student has a right to expect such training from his alma mater. But for it the requirements are importantly different from those that suffice as an introduction to empiric medicine. In the first place, as Pasteur said, we can not have the fruit without the tree. For scientific medicine the student must, perforce, be thoroughly trained in his sciences before he can really grasp instruction or truly profit from his medical teaching. One of the aims of his instruction in empiric medicine is to teach him to observe for himself; so in his instruction in scientific medicine, one of its aims is to enable him to apply science for himself. How small a fraction of all the realities of medical practise can be met in the few years of preparation of the student in the clinic as he passes through it in his school career! His teacher knows that well, and uses the cases there as types whereby the principles of medicine can be fixed as a beginning. The rest must be accomplished by the man himself, as his life's work. It is necessary that the student go forth from his school equipped not only with the present applications of science to disease, but so possessed of root principles of the sciences adjunct to medicine that he may grasp and intelligently use the further developments of scientific medicine after he is weaned from his instructors and the school. That is a way to obtain enlightened progress in professional practise. What truer safeguard can a man have, alone it may be, and isolated from the centers of knowledge, what truer safeguard can he have against all the pseudo-scientific quackeries of the day, than some real knowledge of the principles of the sciences, along whose lines the discoveries of medicine must develop?

Therefore it is that the burden of obligation falls heavily nowadays upon the teaching resources of every faculty of medicine worthy of the name. There is, in the first place, the burden of increased intellectual labor. Both for the learner and the teacher is this true. To seize the proffered assistance of these great and complex sciences is not always easy. These studies are more difficult than those that were needed once, and they take longer to acquire. The mere instrumentarium of modern chemistry and physics, as applied to medicine, and of physiology and pathology, and bacteriology, of itself suffices to bring conviction of the increased difficulty and longer training due for these studies now preparatory to medicine.

Further, these initiatory studies have become vastly more costly than was all that formerly was required. Experts have to be found who can devote themselves heart and soul and undividedly to their particular subject. Laboratories have to be erected and equipped, and on a scale that makes them a distinct feature of the modern world. Those that we see now here are models of their kind; wise foresight has planned them; public-spirited enterprise has constructed them accordant with that plan. Nor does the achievement end with their erection. The laboratories and their equipment are but the factory and the plant; both fail in their purpose if they halt for sustenance. And beyond that the likeness does not go. The factory, once started, if it be wanted, can expect to pay, to support itself. Not so the laboratory. The laboratory is both a school of instruction and a school of thought. Well, then, no higher instruction can be expected unaided to pay the expenses it

involves; it can only do so at the expense of those who come to learn, and that is to put its teaching beyond the reach of all but the wealthier few. And the instruction is costly, for it has to be practical. And another source of expense is that the laboratory has not only to distribute knowledge, but to manufacture it. The duties of a university do not begin and end with the disciplinary and didactic. Besides schools of instruction, they must be schools of thought. To be this latter, the laboratory must pursue research. Even for the welfare of the class-teaching this is essential. Instructive lectures may be given by men of ability, the whole of whose knowledge is second-hand, but it is doubtful whether the real life of science can be fully felt and communicated by one who has not himself learnt by direct inquiry from nature. Nothing more augments the teacher's power of impressive and incisive teaching than to have faced problems of his subject himself as an original enquirer. And, after rudiments have been once fairly acquired, there is for good students no training equal to that given by following even a small research under an experienced leader.

So truly does the laboratory become a school of thought. The student should enter on his study of a natural science through the portal of its fundamental experiments. The attitude his mind thus takes is the true one—the only true one—for further insight into the subject. Too often humanistic studies at school have tended to kill the natural philosopher within the child—to destroy that innate curiosity for facts, the healthy heritage of childhood. He leaves school a little book-man. Even as to the phenomena of nature, he has been insensibly led to ask for statements upon authority, rather than to turn his own senses and observation to the phenomena themselves. To learn a science or acquire an art resting upon sciences, the first thing to do is to look at the fundamental facts for oneself. Our great teachers of medicine teach upon this plan. They teach where they learned, not in the library, but from the bedside of the sick. In laboratories such as those raised here for pathology and physiology and hygiene students can learn these sciences as medicine is learned in the hospital ward by direct inquiry into nature. The teachers you give them are men who have won widely recognized distinction as themselves direct enquirers into nature. Worthy students will appreciate the double boon their alma mater gives them—the means of learning at first hand those secrets of nature which lie at the root of their craft's skill—and to learn them under guidance by men who excel in unraveling such secrets.

Only by enabling men to continue their learning after their teaching is over can we secure the greatest advantage any educational system can afford. Your laboratories here will encourage post-graduate work. We look with keen interest to the researches that will flow from them. No subjects offer finer fields for research than do the progressive studies, physiology, and pathology, to which your new university buildings are consecrated. And of the functions of a laboratory, research is not the least costly. We in the old country find that. Our central government has done little to support research. Our nation, proud of its success in things practical, has been prone to despise the abstract and the theoretical. We do so foolishly; we do so at our peril. Behind all practical application there is a region of intellectual action to which, though our practical men have contributed little, they owe the whole of their supplies. Theory, if a goose, is the goose of the fairy tale that lays the golden eggs. No more such eggs if once you let her die. To speak of theoretic

knowledge slightingly is for the lips of the fool. The value of abstract research to a country is becoming more widely acknowledged among us than it was. Sir John Brunner said the other day, at Liverpool, that there was no better investment for a business man than the encouragement of scientific research, and that every penny of the wealth he possesses has come from the application of science to commerce and to manufacture. And we find that munificent citizens have and do come forward among us and meet by their individual gifts, the pressing needs in this respect of our community at large.

But we welcome a new era dawning on us. Liverpool, Birmingham, Sheffield and other great centers begin to regard the local university as an institution entitled to support from the public means, for instance, by subsidy from public rates. Such subsidies can be used also for studies which do not come within allotment from the smaller subsidy from the central government: medicine, for instance. Proud of the young universities—to which yours of Toronto is a time-honored veteran—communities and local governments are encouraging research within our universities. They do not expect such research to be able to pay its own way, but they recognize that indirectly it does pay the community that gives it a home. They feel it a duty which they owe themselves. Is not the university a part of their own life, and is not research a part of the university's life-blood? They feel it a right, due to their own higher selves. It stimulates progress. Supported by the large-handed sympathy of the community and the local government, it means quicker advance, both material and mental, it means invention, and it means medical discovery. And *qui facit per alium facit per se*, is a motto worthy of a state.

What, then, are finally the uses of these laboratories now opened by your university? They will assist in training men for various honorable callings, especially for that most ancient one of medicine. They will assist, no doubt, also to render life by practical applications of science still more different from what it was only a short generation ago. They will assist to bring home and distribute to your community treasures of knowledge from all the quarters of the globe. They will assist —and it is thought dear to a high-spirited people—to add, by their own contribution, to the sum total of the treasures of knowledge of the whole human race. *'Noblesse oblige'* appeals not only to chivalrous individuals but to chivalrous nations.

Yet their highest office seems to me, perhaps, not even these high ones, but a more difficult still. Genius can not by any community, however wealthy and powerful, be made to order. In biblical language, it is the gift of God. All a community can do toward obtaining it, be our riches and willingness a thousandfold what they are, is to ensure the rare and glorious plant a meed of freedom, light and warmth for blossoming upon our soil. Who can doubt that in this population here genius exists —not sown, it is true, broadcast, for nowhere is it thus—yet existent, scattered up and down? This it is for the community to foster, to discover.

By the help of these finely built and finished laboratories this much in one direction can be done. The problem to which a wise country turns is the discovery less of things than of men. By these laboratories, adequately supported, your community can create opportunity for the exercise of powers which come from sources within itself, but are utterly beyond its power to produce at will. Their loftiest function is creation of this opportunity. For that aim the studies in them must be followed with no single narrow technical purpose, but must be wide of scope and free of access

to every rank of students. So shall these laboratories prove a corner-stone for the upbuilding of a temple of knowledge, and a touchstone for the best ore of intellect in all the width of this great land.

C. S. Sherrington.
University College, Liverpool.

THE NEW AGRICULTURAL EDUCATION.*

There is now largely increased interest in agricultural education in all parts of the country. This is due in large measure to a radical change in the foundations of the system of agricultural education. In the past the courses of instruction were based on the sciences related to agriculture, whereas now they are being based on the science and art of agriculture itself. Owing chiefly to the researches of the agricultural experiment stations and kindred institutions in this country and abroad, there is now a distinct body of knowledge which may fairly be called the science of agriculture. This science treats of the production of plants and animals useful to man, and the uses of such plants and animals. It is divided into plant production, which includes agronomy (field crops), horticulture and forestry, zootechny or animal production; agrotechny or agricultural technology (including dairying, sugar-making, etc., adulteration of foods and feeding stuffs, etc.); rural engineering and rural economics.

This fact has lately been recognized in the reorganization of the United States Department of Agriculture, where we now have Bureaus of Soils, Plant Industry, Forestry and Animal Industry, in which are grouped a large number of scientists representing various specialties in agricultural science. These men now feel that they are working primarily as agricultural scientists rather than as botanists, chemists, physicists or physiologists. Their natural outlook is, therefore, in the direction of promoting the advancement of agricultural science and practise, and they are disposed to lay under contribution every science required to work out the complex problems of agriculture.

Many of our agricultural colleges are also being reorganized on this basis. A notable illustration of the results is found in the Illinois College of Agriculture, where there are now twenty men teaching different branches of the science of agriculture and the number of students has increased tenfold in four years.

While the number of students in the agricultural colleges has been relatively small, they have done a great work. From them have come in large measure the men who have made the science of agriculture, who have manned the experiment stations, who have brought about changes in our agricultural practise which have largely increased production, and, what is more important, have set our intelligent farmers on the highway of rational progress. These men have also laid the foundations for a system of agricultural education which is already affecting the thought and activity of hundred of thousands of farmers who never have been on the campus of an agricultural college, and which in the not distant future will directly touch the masses of our rural population.

For the leaders of our agricultural progress have learned, and the general public will soon learn, that the agricultural college is not the only institution required to give us a thoroughly effective system of agricultural education. And already representatives of the different institutions comprised in a comprehensive system of agricultural education are actually in operation in different parts of the country, so that we can now clearly understand what the American

* Summary of address at dedication of new agricultural building, New Hampshire College of Agriculture and Mechanic Arts, October 28, 1903.

system of agricultural education is to be. Briefly outlined this system will include: (1) Agricultural experiment stations (*i. e.*, institutions of research), (2) graduate schools, (3) colleges, (4) secondary or high schools, (5) special schools (of dairying, etc.), (6) elementary courses in the common schools and (7) extension work, especially farmers' institutes.

Emphasis must be laid on the research work of the agricultural experiment stations, for on their success depends not only the advancement of agricultural practice in particular regions, but also the effectiveness of the agricultural colleges and other institutions for agricultural education. For it is the new knowledge which the stations are gathering through their researches that is required to strengthen and develop the courses of instruction in agriculture. These stations are the fountains from which will flow the streams of knowledge that, on the one hand, will make our farms more productive, and, on the other, will give our youth sound training in the correct principles of agriculture. It is gratifying, therefore, to observe that in the building which we dedicate to-day distinct provision is made for the work of the experiment station.

The courses of instruction in an agricultural college may easily be so grouped that the graduate in agriculture may have a truly liberal education. This is well illustrated by the course of study proposed for our agricultural colleges by standing committees of the Association of American Agricultural Colleges and Experiment Stations. This four-year course includes English, modern languages, psychology, ethics, political economy, general history, constitutional law, drawing, algebra, geometry and trigonometry, as culture studies; next there are the pure sciences—physics, chemistry, botany, zoology, physiology, geology and meteorology; lastly, the vocational studies—agriculture, horticulture and forestry, veterinary science and agricultural chemistry. As regards the time assigned to these subjects, we find two thirds of the entire course is occupied with culture and scientific studies, leaving one third of the time for agricultural science and its applications to the arts of agriculture.

It should be clearly understood that the agricultural college course leading to a bachelor's degree will call for an amount of learning which can only be acquired by years of close application to study. It is therefore not for every boy, any more than any other college course, but only for those whose ability and tastes shall lead them to devote themselves to a large educational effort. As managers of our larger agricultural enterprises, investigators, teachers, journalists, government and state officers, manufacturers of fertilizers, farm machinery and other products resulting from or used in agriculture, we need in the aggregate a large number of men who have received thorough training in the science and art of agriculture. These men should be trained in our agricultural colleges and should at least attain the bachelor's degree. Already there are profitable employment and honorable careers for more men of these classes than our agricultural colleges can supply, and the demand for these graduates in various capacities is rapidly increasing.

The colleges must also help to organize the lower grades of agricultural education. In many of our states if there are to be successful schools of dairying, horticulture, forestry or any other branch of agriculture, they will have to be organized as a part of the agricultural college. And the same is probably true of the agricultural high school. Such an institution is the crying need of our rural communities. When the farm children are through with the district schools they should not be compelled to go

to town or city high schools where agriculture is entirely neglected. They should be provided with schools similar to the manual training high schools maintained in many of our cities, in which, along with culture and scientific studies, the theory and practice of agriculture shall be systematically taught.

It may, perhaps, be said that this is a large and expensive program. But agriculture is making no unreasonable demands. She is asking only the same treatment which is already accorded other arts and professions. The clergymen, lawyers and doctors receive their education very largely at public expense. Schools of technology and courses of manual training are being rapidly multiplied as parts of our public school system. The city schools in ever-increasing measure directly prepare their pupils for the pursuits of urban communities. The farmer is not to be deprived of similar privileges along the lines of his art. The republic can not afford to maintain the great fundamental industry of agriculture on the basis of ignorance and conservatism. Reckoned at their lowest value, the public funds spent in technical education, whether in engineering, trades or agriculture, are a most profitable financial investment. But they pay vastly richer returns in the broader mental outlook and higher morality of the educated masses.

While acknowledging all this as regards the agriculture of the United States as a whole, some people have had the idea that the agriculture of New England is gradually disappearing and will ultimately be extinct. A most absurd idea! The agriculture of New England has undergone great changes in the past half century. It has passed through a period of depression while the great Mississippi Valley was being occupied and its vast prairies were almost as free as air to the settler. But that day is gone, for the lands of the Mississippi Valley are filled with farmers. Irrigation will ultimately put under the plow millions of acres west of the great river, but this development will necessarily be slow and expensive even with national aid. The natural increase of population, the great tide of immigration, the growing demands of the old world for food to stop the hunger of its teeming millions—all these things are to make our agriculture more remunerative and to bring into more profitable use the lands of New England, as well as of the rest of the country. According to the United States census, in the period between 1890 and 1900 the annual value of the farm products of New Hampshire increased from less than thirteen to nearly twenty-two millions of dollars.

And even now, and in the days to come in far greater measure, it is the trained farmer who will make the best living out of New England soils. For here will flourish an intensive and highly specialized agriculture. The forests are to be reconstructed and profitably utilized as a permanent source of wealth. Horticulture, dairying and poultry raising—pursuits which call for a rare combination of scientific knowledge and practical skill for their most profitable development—are to make the restricted fields of New England far more productive than many broader areas beyond the Alleghenies. But these highly specialized and developed agricultural industries must rest on a basis of scientific and technical education if they are to have great and enduring success. To bring this about is the mission of the agricultural college. It is a great task and a tremendous responsibility. In the older lines of education the college has a quite restricted duty and the methods of its work are relatively fixed, so that its managers and faculty have a comparatively easy burden to bear. But the managers and faculty of an

agricultural college of the present day must not only teach the students whom they can draw into their class-room, but they must also gather out of the realms of the unknown the materials to complete the new science of agriculture on which the scheme of education rests; they must organize and bring into successful operation a whole system of education from the common schools to the university department of research; they must overcome the prejudices and traditions of a most conservative constituency; they must create and develop into active and permanent life a public sentiment which shall result in the adequate equipment and maintenance of a comprehensive system of agricultural education. It is, indeed, a great burden which rests upon the shoulders of this board of trustees, this youthful president and this learned faculty.

But the encouragements to strenuous activity in this cause are also great, for already mighty forces are allied to push on this enterprise. The United States government has pledged itself to the permanent financial support of the agricultural colleges and experiment stations, and is giving them besides the active aid of its great Department of Agriculture. The state of New Hampshire is backing this work with its public revenues, and this building testifies that the state regards the agricultural college as one of its permanent institutions. The workers in the cause of agricultural education here have also those incitements to high endeavor which come from the consciousness of belonging to a great system of institutions, that throughout the length and breadth of the union, and in all the civilized countries of the globe, are competing in generous rivalry for the advancement of fundamental interests of mankind. And what is most significant and stimulating is the sympathetic and active aid of rapidly increasing hosts of intelligent farmers and other public-spirited citizens who individually and through their organizations are helping to make the agricultural college what it should be, and develop a system of agricultural education which shall erelong reach every man, woman and child on the 5,000,000 farms of the United States.

A. C. TRUE.

U. S. DEPARTMENT OF AGRICULTURE.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for October opens with the first of a series of papers on 'Adaptation to Aquatic, Arboreal, Fossorial and Cursorial Habits in Mammals,' the present one being on 'Aquatic Adaptations,' by Raymond C. Osburn. Edwin G. Conklin has a paper on 'Amitosis in the Egg Follicle Cells of the Cricket,' concluding that it is an accompaniment of cellular senescence. Edward W. Berry describes 'New Species of Plants from the Matawan Formation' and O. P. Hay has 'Some Remarks on the Fossil Fishes of Mount Lebanon, Syria.' The concluding paper, by R. W. Shufeldt, is 'On the Osteology and Systematic Position of the Kingfishers.' The number contains the Quarterly Record of gifts, appointments, retirements and deaths.

The Popular Science Monthly for November has articles on 'The Renaissance of Science,' by Edward S. Holden; 'Life in Other Worlds,' by F. J. Allen; 'The New West Point,' by William J. Roe, and a plea for 'A Laboratory for the Study of Marine Zoology in the Tropical Atlantic,' by Alfred G. Mayer, the Tortugas being the locality suggested with Jamaica as a possible alternative. David Starr Jordan discusses 'The Parent Stream Theory of the Return of Salmon,' showing that the evidence is not in favor of it, and J. A. Fleming contributes the sixth of his papers on 'Hertzian Wave Wireless Telegraphy.' Allan McLaughlin shows 'The Bright Side of Russian Immigration,' and Norman Lockyer treats of 'The Influence of Brainpower on History,' presenting arguments for the national support of universities.

The Museums Journal of Great Britain for October contains articles on 'The British Association' and 'The Mannheim Conference on Museums as Places of Popular Culture,' and the concluding portion of the address of the president, which is illustrated by a number of plates. E. M. Holmes has an article on 'The Preservation of Natural Colours in Dried Plants.' There is the customary number of important notes concerning various museums and museum matters.

SOCIETIES AND ACADEMIES.

THE NATIONAL ACADEMY OF SCIENCES.

The academy held its autumn meeting at Chicago on November 17, 18 and 19. The event was of special importance owing to the fact that the academy has not hitherto met west of the Atlantic seaboard. Chicago has recently become one of the chief scientific and educational centers of the country, and, apart from the program of papers, there was much to interest the visiting members. The members of the academy were very generously entertained by the president and other officers of the University of Chicago and by the director of the Yerkes Observatory. Mr. Alexander Agassiz presided, and the following program was presented:

T. C. Chamberlin: 'Preliminary Report on the Agassiz Data relative to Underground Temperatures at the Calumet and Hecla Mine.'

C. E. Dutton: 'The Velocities of Earthquake Vibrations and their Significance.'

A. P. Mathews: 'The Relation between Solution Tension and Physiological Action of the Elements.' Introduced by C. O. Whitman.

S. W. Williston: 'On the Distribution and the Classification of the Plesiosaurs.' Introduced by T. C. Chamberlin.

C. O. Whitman: 'The Evolution of the Wing-Bars in Pigeons.'

Chas. B. Davenport: 'Evolution without Mutation.' Introduced by C. O. Whitman.

J. McK. Cattell: 'The Measurement of Scientific Merit.'

J. Stieglitz: 'Stereoisomeric Nitrogen Compounds.' Introduced by A. A. Michelson.

Charles Baskerville: 'On the Recent Investigations of the Rare Earths in the Laboratory of the University of North Carolina' (by title). Introduced by Ira Remsen.

E. E. Barnard: 'Some Peculiarities of Comets' Tails, and their Probable Explanation.' Introduced by George E. Hale.

Edwin B. Frost: 'Stars of the Orion Class.' Introduced by George E. Hale.

George E. Hale: 'On the Nature of the Solar Flocculi.'

Geo. C. Comstock: 'The Relation of Stellar Magnitude to Stellar Distances.'

A. A. Michelson: 'Spectra of Imperfect Gratings.'

Stephen Moulton Babcock: 'The Relations of Weight and Energy.' Introduced by Charles R. Van Hise.

C. S. Slichter: 'The Propagation of Ground Water Waves.' Introduced by Geo. C. Comstock.

William H. Brewer: 'Biographical Memoir of Sereno Watson.'

Charles R. Van Hise: 'The International Geographical Congress and a Geophysical Laboratory.'

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of October 19, 1903, when, for the first time, the academy met in its new building, Professor Nipher gave a verbal abstract of the results of his paper on the 'Law of Nebular Contraction,' which has just been published in the *Transactions*. He also remarked that the molecular conditions in nebulæ of different gases were being examined, and some very interesting results are at once evident. If a series of nebulæ of various gases have the same mass internal to the same radius, the average molecular velocities would be the same for all gases. The velocity which would enable a molecule to escape from the nebula is 2.71 times the average molecular velocity, and this ratio is constant for all parts of the nebula. If the entire solar system formed the core of such a nebula, and the mass of the solar system extended to Neptune's orbit, the density at that distance from the center of the nucleus would be less than that in a Crookes tube. This opens up some very interesting questions concerning the history of such a mass. It would appear that such a gravitating mass would lose some heat by the escape of the more rapidly moving molecules, as well as by radiation.

Professor Keiser read a paper on a method of determining the amount of free lime in cements. He finds that this can be done by determining the amount of water absorbed. By measuring this absorption in samples containing known amounts, the precautions to be taken in manipulation have been found. The determination only requires about twenty minutes.

Professor Nipher presented a diagram on which was drawn the curve of speed of the trotting horse. This curve represents the equation published by him twenty years ago. On the same diagram was shown a belt of observed values representing the performance of every horse who has broken the speed record since 1845. In some cases a single horse has broken the record several times in the same year. All such observations were included. The points representing these observations formed a belt within which was the curve of predicted speed. The agreement was considered very satisfactory.

AT the meeting of November 2, 1903, Dr. J. A. Harris presented for publication a paper on 'Polygamy in *Solanum*' and a paper on 'The Germination of *Pachira*,' and Mr. B. F. Bush presented a paper entitled 'A New Genus of Grasses.'

The secretary addressed the academy on its past history and prospects, in connection with the occupancy of its new home.

WILLIAM TRELEASE,
Recording Secretary.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

THE 374th meeting, the first of the fall, was held Saturday, October 17.

Under the head of 'Notes' L. O. Howard stated that attention having been drawn to the great variance in the statements regarding the length of the thread of a silk worm's cocoon, he had had the threads of four specimens measured. They were found to be from 880 to 1,102 yards in length, the published figures referred to varying from 1,100 yards to 11 miles.

T. S. Palmer spoke on 'Indexing Scientific Names, with special reference to the Genera of Mammals.' After mentioning the recent appearance of Sherborne's 'Index Animalium,' and the volume of Waterhouse supplementing the 'Nomenclator Zoologicus' of Scudder, he said that for nearly fourteen years past he had been engaged in the preparation of a list of the genera of mammals, living and extinct. This work was to give the date and place of publication, the character and location of the specimen, etymology, and indicate whether or not it was preoccupied. The list, which contained about 5,000 names, was to be arranged both alphabetically and zoologically, so that it would be possible not merely to ascertain whether or not a given name had been used, but to see readily what genera were comprised in any given group. Mr. Palmer then spoke of some of the difficulties that had been encountered in tracing some of the names and their derivation, and said that it was hoped that the list would be issued in December.

O. F. Cook presented a paper on 'Central American Mutations of Coffee,' saying that some of the varieties of coffee were well marked and known by special names. He said that a study of these variations had led to conclusions directly opposed to those of de Vries drawn from observations on primroses; that instead of these variations being natural steps in the evolution of species, they were the result of close inbreeding and indications of degeneration.

W. P. Hay described 'Terrapin Culture in the United States,' giving the results of his observations on the diamond back terrapins in the region of Chesapeake Bay. He gave a résumé of the laws relating to terrapins, intimating that they were the most stringent where least needed and practically not enforced anywhere. The turtles were impounded in large numbers and the eggs were deposited freely and many hatched, but owing to the prevailing conditions and lack of care the larger proportion of young were destroyed. The young grew about an inch during the first year, but attained maturity slowly, probably agreeing in this respect with *Chrysemys picta*. Like this species, four distinct sizes of eggs could be distinguished in the diamond back terrapin aside from the general mass of small,

unfertilized ova. In order to supply the demand for terrapin many were imported from the southern states, including representatives of two distinct and, as yet, undescribed species. It had been thought that these might be crossed with the Chesapeake terrapin, but as none were kept a sufficient length of time, four years, after importation no results had been obtained. Owing to close hunting and disregard of the laws, the Chesapeake terrapin was threatened with extermination, and the simplest remedy suggested was to forbid the sale of the larger terrapins, since these were invariably breeding females.

F. A. Lucas.

THE TORREY BOTANICAL CLUB.

At a meeting of the club held at the Botanical Garden on October 28 the following scientific notes and papers were presented:

Dr. MacDougal called attention to the abnormal fall blooming of certain plants. In one case mentioned the spring flowering of certain plants was retarded till fall, owing to the presence of a mass of ice, this being a case of retarded development. He exhibited plants with flowers now open that should not normally open till next spring, this being accelerated development caused by the prevailing climatic conditions.

Dr. Britton exhibited two forms of the common marsh mallow, one with pink flowers, the other with white flowers with a crimson center. The first is the well-known *Hibiscus Moscheutos* L. The second form is not uncommon in various localities, but has been considered merely a color variation. Recently it has been observed that the fruits of the two forms are very different, showing that they should be considered distinct species. Drawings of the fruits were exhibited. No name has as yet been proposed for the white-flowered form.

Dr. Livingston spoke on the 'Influence of Osmotic Pressure on the Cell.' One of the widely accepted theories of the action of osmotic pressure is that it is comparable to gas pressure. It can only act, however, in the presence of water. Soluble salts tend to diffuse throughout a given volume of water just as gases do in a confined space. In cellular tissues there is no break in the water connection, since the cell wall is permeable by water and by the salts dissolved in it. The protoplasmic lining of the cell is, however, only semi-permeable, since it allows the passage of some substances while preventing that of others. When living cells are transferred from a thin dilute medium to a denser one the tendency is for them to lose part of the water they contain. The cell contents thus become more or less shriveled. Conversely, when a cell is transferred to a more dilute medium it swells and becomes more turgid. Strong solutions tend to check vital activity. Removal to a dense medium often materially alters the form of growth of an organism, the tendency being to assume short thick forms in the dense medium and longer and more slender forms in the dilute ones. With different substances that are not poisonous the cell seems to give the same response when a strength of each is used that would exert the same osmotic pressure, showing that it is the pressure and not the character of the substance that produces the effect. The extraction of water from the cell means the concentration of the solution of all the various salts and other dissolved substances that are contained in it. Varying strengths of the same salt are known to affect the growth of plants very diversely, and this suggests an interesting field for further investigation.

The paper brought out an interesting discussion as to the probable effect on the aquatic vegetation of a gradual change from fresh to salt-water conditions.

Mr. Earle discussed 'Generic Limits among the Agaricaceæ.' He called attention to the artificial character of the genera that are now recognized and the unnatural grouping of species that resulted from the use of only two or three characters as the basis of genera. A more natural grouping would require that the sum total of all the characters should be considered in defining genera.

F. S. Earle,
Secretary.

CLEMSON COLLEGE SCIENCE CLUB.

THE club held its first regular meeting of the present scholastic year on the evening of September 18. Professor W. M. Riggs presented a communication entitled 'The Fixation of Atmospheric Nitrogen.' Priestley's observation of the effect produced in the atmosphere by the discharge of an electric spark was mentioned as being the basis of the present experimental work now being done on this subject. The work now being done at Niagara Falls by Messrs. Bradley and Lovejoy for the purpose of making the process of 'fixation' a commercial success was described in detail. The machines used in the process were illustrated by drawings. The great economic results that would flow from a successful commercial application of the process were emphasized. Professor H. Benton discussed 'Soil Inoculation.' The speaker referred to the fact, long since known, that the cultivation of legumes has always been found beneficial to the growth of succeeding crops. The reasons for this were explained. In view of the fact that each species of legume has its own species of nitrogen-assimilating bacteria, it is necessary that there be present in the soil the particular species of bacteria adapted to the crop to be grown. The different methods of inoculation were described in detail. The speaker closed by giving some figures showing the efficacy of soil inoculation in the case of some hay crops grown in Alabama.

Professor F. S. Shiver read a paper entitled 'The Centenary of the Metric System.' This paper gave in detail the evolution and development of the metric system. Some of the earlier attempts at unification of the French *measures,* prior to the advent of the metric system, were referred to. Picard's work was shown to have furnished the scientific principle upon which the metric system rests. The attempts to legalize the new system in France and elsewhere were recounted. The system was shown to have entered a new phase, that of becoming an international standard, in 1875. The work of the International Commission, as well as of the International Bureau of Weights and Measures, was explained. The methods of preparing the international copies of the meter and kilogram were noted. In conclusion, the work of Michelson in comparing the basis of the metric system with a natural unit, namely, the length of a wave of the red light of cadmium, was referred to. The work of Guillaume on nickel steels and their application to metrology was also mentioned.

F. S. SHIVER,
Secty.-Treas.

CLEMSON COLLEGE, S. C.,
October, 1903.

THE GEOLOGICAL SOCIETY OF AMERICAN UNIVERSITIES.

ABOUT three years ago the members of the Geological Society at Leland Stanford Junior University began considering the possibility of forming a general geological society among the students of the various American universities or schools of mines having efficient departments of geology or mining. A thorough canvass of the situation resulted in the conclusion that such an organization would not only be possible, but most advisable. The Stanford society, acting on this belief, sent letters to the departments of geology or mining at a number of the principal universities, enclosing in each a constitution for a general society which was tentatively offered for their consideration.

Answers favorable to the formation of the general society were received from a majority of the departments addressed, and at two of the universities, where before there had been no such organizations, the students formed local sections. A rather intermittent correspondence between the Stanford society and these two sections and several other local geological clubs followed, but no definite action looking toward the permanent organization of a general society took place.

The matter of such an association now having been more or less favorably discussed at several institutions for the past year or more, the time seems opportune to proceed with a permanent organization. As nearly all the institutions interested now have local clubs or societies, the forming of a gen-

eral society will practically only require the affiliation of the local sections which are already in existence. This may be done by correspondence through the secretary of the originating society at Stanford University.

The desirability of such an organization can not be doubted, as it would form a basis for an acquaintanceship among students in geology and mining which could not but be a benefit and a pleasure to them. The social or fraternal element would be paramount in the general society, but the usefulness of the organization would by no means be limited to this factor. Such an organization would have a wide influence as a medium of exchange of thoughts and ideas among college men interested in geology or mining, both before and after their departure from their alma mater. These are but two of the many advantages which such an organization would develop as its membership and influence grew.

A constitution embodying the organization and aims of a general society has been tentatively drawn up. Its features are, in the main, similar to those common to such societies, and but a few points, some of which pertain more properly to the constitution or by-laws of the local sections, will require explanation here. The name, 'Geological Society of American Universities,' is thought to indicate as nearly as possible the exact nature of the society; and 'section' is deemed a good designation for the local branches. Active membership is restricted to those students whose major subject is geology or mining, and who receive a three fourths vote of the society. Another requirement for membership, which, however, is left optional with each section, but which appears advisable where practicable, is that making it necessary for the candidate to receive a recommendation for good scholarship from the head of his department. It is the history of 'open' societies that sooner or later the interest in them lags; hence, the placing of restrictions on the membership. The society aims to take in only such men as really strengthen it, and to that end have made superior scholarship a requisite. Although practically a senior and graduate society its membership is not so limited, for it is intended to take in men who enter the universities possessing geological or mining experience and are considered otherwise eligible. Honorary and associate members are elected from outside the departments of geology and mining.

The society is a social as well as a technical organization, and in the local as well as in the general organization this fact is well emphasized; the meetings being held for the most part at the rooms or homes of its members. The formal atmosphere surrounding a meeting in a lecture hall or laboratory is thus removed and the effect is most wholesome on the life of the society.

At each meeting some member is assigned to read a paper or give a talk concerning some geological or mining problem; all papers or talks being based on the speaker's own experience or work. Friendly criticism and discussion generally follow each paper, and both the speaker and the society derive much benefit from this informal exchange of ideas. A social hour, interspersed with refreshments, usually terminates the meetings. Open or special meetings are sometimes held at which more formal talks are given, generally by some one outside of the section.

The emblem of the society consists of a design wrought in gold of a miniature geologist's pick, on the handle of which is impressed an irregular gold nugget, bearing in enamel the initials 'G. S. A. U.' The seal of the society is an image of the emblem.

As it would probably be impossible for the society to hold annual meetings at once, temporary provision has been made in the constitution for the transaction of all necessary business by correspondence. The growth of the society, with its ever increasing number of graduate members, would soon make possible annual meetings or conventions, as is customary with like organizations.

The history, objects and a brief outline of the workings of the proposed 'Geological Society of American Universities' has now been given. All that yet remains to be done to permanently establish this society, which surely has a broad and useful existence before it, is for the college men of this country to

enter into it with the zest and interest worthy of the professions represented.

RALPH ARNOLD,
DE WITT C. WILEY.
U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C., and
STANFORD UNIVERSITY, CALIFORNIA.

DISCUSSION AND CORRESPONDENCE.

THE MEXICAN COTTON BOLL WEEVIL.

TO THE EDITOR OF SCIENCE: In your issue of November 13 (p. 640) you quote from *Bradstreet's* an item regarding the loss to the cotton crop of Texas through the ravages of the Mexican cotton boll weevil. In the course of the article *Bradstreet's* states that six months ago it advocated a careful consideration of the subject by congress. From this quotation alone *Bradstreet's* seems to be singularly misinformed as to what actually has been done by the government, and the quotation will, therefore, mislead your readers.

In 1894 an investigation of this insect was begun by the Division of Entomology of the U. S. Department of Agriculture, and in 1896 and 1897 circulars were published which indicated the great danger to the future of cotton in the United States and proposed remedial treatment. The governor of the state and the legislature were advised by the department of the condition of affairs and the dangerous prospects, and the legislature was urged to pass a crop pest law, the enforcement of which would have resulted in the confinement of the insect to a restricted region in extreme southern Texas, and possibly in its extermination even in that region. The legislation proposed was not enacted. For the past three years the Division of Entomology has been carrying on further investigations through appropriations from congress of $10,000 in the fiscal year 1901–2, $20,000 in 1902–3, and $30,000 in 1903–4. It has resulted from this work that, while no method of extermination has been discovered, it has been demonstrated beyond a doubt that it is possible, even under present conditions and in the worst infested portions of Texas, to raise a fair crop of cotton in spite of the weevil. Experimental demonstrations have been made the past summer on several hundred acres of cotton lands at six stations under the control of the Division of Entomology, and on this controlled land from a half of a bale to one bale per acre of cotton has been already harvested, while in adjoining territory the average crop has not exceeded one bale to from six to fifteen acres.

L. O. HOWARD.

SHORTER ARTICLES.

SOME INSECT REFLEXES.

IN the course of some experiments on the sense-reactions of honey-bees, I have kept a small community of Italian bees in a glass-sided, narrow, high observation hive, so made that any particular bee, marked, which it is desired to observe constantly, can not escape this observation. The hive contains but two frames, one above the other, and is made wholly of glass, except for the wooden frame. It is kept covered, except during observation periods, by a black cloth jacket. The bees live contentedly and normally in this small hive, needing only occasional feeding at times when so many cells are given up for brood that there are not enough left for sufficient stored food supplies. Last spring at the normal swarming time, while standing near the jacketed hive, I heard the excited hum of a beginning swarm and noted the first issuers rushing pellmell from the entrance. Interested to see the behavior of the community in the hive during such an ecstatic condition as that of swarming, I lifted the cloth jacket, when the excited mass of bees which was pushing frantically down to the small exit in the lower corner of the hive turned with one accord about face and rushed directly upward away from the opening toward and to the top of the hive. Here the bees jammed, struggling violently. I slipped the jacket partly on; the ones covered turned down; the ones below stood undecided; I dropped the jacket completely; the mass began issuing from the exit again; I pulled off the jacket, and again the whole community of excited bees flowed—that is the word for it, so perfectly aligned and so evenly moving were all the individuals of the bee current—up to the closed top of the hive. Leaving the jacket off

permanently, I prevented the issuing of the swarm until the ecstasy was passed and the usual quietly busy life of the hive was resumed. About three hours later there was a similar performance and failure to issue from the quickly unjacketed hive. On the next day another attempt to swarm was made, and after nearly an hour of struggling and moving up and down, depending on my manipulation of the black jacket, most of the bees got out of the hive's opening and the swarming came off on a weed bunch near the laboratory. That the issuance from the hive at swarming time depends upon a sudden extra-development of positive heliotropism seems obvious. The ecstasy comes and the bees crowd for the one spot of light in the normal hive, namely, the entrance opening. But when the covering jacket is lifted and the light comes strongly in from above—my hive was under a skylight—they rush toward the top, that is, toward the light. Jacket on and light shut off from above, down they rush; jacket off and light stronger from above than below and they respond like iron filings in front of an electromagnet which has its current suddenly turned on. What produces the sudden strong heliotropism just as the swarming ecstasy comes on? That is beyond my observation.

Dr. Loeb tells me that he has observed and recorded a strong positive heliotropism in the winged male and female ants at mating time. They rush from their underground nest and take wing directly toward the strongest light. With both bees and ants this flying toward the light at swarming and mating time, respectively, has obvious advantages. It keeps the swarm together and it takes them away from the old community. Swarming and mating flights are distribution and migration of the species to new ground where are food and space unneeded by the old community.

During the last three years I have, with a student, Mrs. Bell, been rearing silkworms under quantitatively determined varied conditions of food supply, in an attempt to determine, also quantitatively, the extent and character of the induced variations. In these experiments silkworms separated into various lots (the individuals in each lot kept also apart so that each may get its rightful share of food) are variously fed through their life on an optimum of food, on one half optimum and on a minimum amount, that is, one which will just keep the worms alive, developing and growing. As the optimum amount is that which permits the larvæ to feed almost continuously, and as each under-fed worm eats up as rapidly as possible its full supply, it is evident that the half-fed and minimum-fed worms have to spend long hours of non-feeding, rest and quiet and—if it may be—meditation. Now such a period of non-feeding and inactivity is precisely a normal pre-molting phenomenon of all silkworms—and of other lepidopterous larvæ, too, for that matter. With this in mind it is interesting to note that a common phenomenon in the life of the under-fed worms was an abnormal increase in moltings; that instead of adhering to the time-honored and Bombyx-approved habit of molting four times (exclusive of pupation) during the larval life, most of these half-starved larvæ, with artificially imposed repeated periods of non-feeding, molted five and a few even six times. It may be expected that such a sapping of vitality as these starvation rations must have produced would result in a lessening of the physiological activity, and a giving up of one or more moltings rather than an increase in the number of these betrayals of growing pains. But no, there are more rather than fewer moltings. Now in actual molting, the loosening from the body of the old cuticle results from the secretion by skin glands of a so-called molting fluid; this secretion occurs during the non-feeding resting stage normally immediately preceding the molting. Can the abnormally induced non-feeding, inactive periods imposed on the under-fed worms have been the sufficient stimulus for setting up this secretion and accumulation of the molting fluid resulting, as usual, in a loosening of the cuticle? That is, do lepidopterous larvæ molt not just because molting is needed at some particular time but because the cuticle gets pushed off by a fluid which gets formed and excreted whenever the larva stops feeding? Of course the insect that wisely times its non-

feeding rests so that its moltings shall come to best advantage for the necessities of growth is the insect that is represented by descendants now-a-days. But is molting any the less a reflex for that?

Loeb, in his 'Comparative Physiology of the Brain,' records certain observations on the larvæ of the moth *Porthetria* sp. with regard to their regular movements up the stem of the food plant, suggesting that this climbing up is a positively heliotropic reflex, resulting in the (advantageous) finding of the tender new leaves and buds of the food plant. I have observed the traveling behavior of the larvæ of three species of moths, these larvæ being the mulberry silkworm, a geometer found on lindens and an unknown species (the adult was not bred) which may be called No. 3. In each case only larvæ just hatched from the egg were used, thus eliminating any results of experience or imitation. Twigs of food plants were so arranged that there were for each kind of larva cases in which (*a*) the leaves were up and in the light, (*b*) the leaves were up and in the dark, (*c*) the leaves were down and in the light, (*d*) the leaves were down and in the dark, (*e*) the leaves were in horizontal plane with the twig and in the light, (*f*) the leaves were in horizontal plane with the twig and in the dark, (*g*) the leaves and twig were in horizontal plane all equally illuminated, (*h*) the larvæ were put on a part of the twig which was in the dark, (*i*) the larvæ were put on a part of the twig which was in the light. These various cases were easily arranged for by having a number of hollow cylinders about one and a half feet long, three inches in diameter, and open at both ends. The twig with leaves could be put into or partly into the cylinder, as desired, and the cylinder put in vertical or horizontal position, as wished.

Without taking space to give in actual detail the behavior of the tiny larvæ of the three different species, I may summarize this behavior as follows: The silkworms moved indifferently toward light or away from it, up or down, until they found food, and then made an end of traveling; the linden inch-worms tended strongly to travel toward darkness and when this direction was downward the tendency was greatly strengthened; the unknown No. 3 larvæ tended obviously to travel toward the light, and when this direction was upward the tendency was strongly increased. That is, in these three lepidopterous species, the larvæ of all being leaf feeders and naturally preferring tender new leaves, three different conditions of reaction to light were shown, in one a positive heliotropism, in one a negative heliotropism and in the third sheer indifference to light. This last species, the silkworm, may well be looked on as having lost its earlier sensitiveness to light through panmixia—if there be panmixia—because for generations the silkworm's food has come to him rather than had to be gone to, and there is no more nor better food up or toward light than there is down or away from light or sidewise and in light of the same intensity as that in which he first finds himself. I have reared silkworms in darkness unbroken during their whole life except at moments when the mulberry leaves were thrust into the dark cell, and in no structural or physiological characteristic was there any apparent difference from individuals bred in bright sunlight (alternating with unillumined nights).

It is interesting to note the decided character of the negative heliotropism of the linden inch-worms, as this is the kind of heliotropism which is distinctly unexpected of larvæ which have to find for themselves tender fresh leaves. In a glass cylinder, lighted in its upper half and darkened in its lower half, with linden leaves placed at the very bottom, 92 just hatched larvæ were placed in the lighted half at 11:20 A.M. At 3:30 P.M. 17 larvæ were still in the light half, but 75 were in the lower darkened half, most of them being in the darkest place, that is, at the very bottom *under* the leaves.

Equally marked was the more familiar positive heliotropism of the unknown No. 3. When only two or three inches from leaves put into the darkened half of a glass dish, the whole group of tiny caterpillars, certainly hungry even to death, would keep steadfastly in the light half.

The behavior of these various kinds of

caterpillars, while contradictory if we were inclined to form too hastily a generalization based on the behavior of the *Porthetria* larvæ—a generalization that would explain the going up to light as a reflex which had persisted among all leaf-feeding lepidopterous larvæ because of its advantageous leading of them to the most succulent food—is not at all contradictory of the point of view of the biologist who believes in reflexes. Personally, while still inclined to see more wit in ants than Bethe's extreme confidence in the reflex theory of their behavior would admit, and while recognizing the reasonableness and legitimacy of the query, does the reflex basis of behavior really simplify our conception of the springs of animal behavior?—I am willing, on the evidence of the accumulating observations, to see much of the credit which insects have long enjoyed for the possession of unusual intellectuality and elaborately developed instinct, go by the board. Immediate physicochemical stimuli undoubtedly produce as direct reflexive reactions many of the activities which we have been long interpreting on a basis of complex instincts and associative memory.

VERNON L. KELLOGG.

STANFORD UNIVERSITY, CALIF.

NOTES ON THE VEGETATION OF THE TRANSVAAL.

BEFORE coming to the Transvaal I was informed by a botanist who had some knowledge of the South African flora that the flora of the Transvaal was entirely xerophytic in character, and that it was largely composed of succulent plants—*Euphorbias, Aloes, Mesembryanthemums, Cotyledons, Crassulas* and the like. In my informant's mind it was apparently a continuation of the flora of the Great Karroo.

Imagine my astonishment, therefore, after crossing the Karroo, with its dreary plains so like those of the Great Basin of North America, even in the general aspect and color of its vegetation, to find myself, on waking up one morning, crossing a vast, grassy plateau, the high veldt, practically destitute of trees or shrubs, but producing masses of tall, thick grass, recalling the prairies of the far west. Later I found that this was a fair sample of the vast stretch of country extending from the confines of the Kalahari desert in the west to the summits of the Drakensberg in the east.

Grasses form the most conspicuous features of the Transvaal flora. This is true, at least, of the high veldt. They are only little less abundant in those parts of the bush veldt which I have seen.

Succulents are rare, being practically confined to rocky kopjes, *i. e.,* buttes, and the randjes, *i. e.,* ridges, which cross the country from east to west. Mesembryanthemums are extremely scarce. Bulb and corm-producing plants abound among the grass. A few bushes and small trees, evergreen *Proteas,* caulescent *Aloes* and *Cereus*-like *Euphorbias,* deciduous *Combretums,* etc., also occur on the kopjes and randjes. Patches of diminutive woodland, composed of Doorn-boom (*Acacia horrida*) five to fifteen feet high, are occasionally seen at long intervals in crossing the high veldt, usually in the vicinity of water.

As a rule, however, trees and shrubs are entirely absent. I have driven all day, a distance of sixty miles, without seeing more than one colony of bushes, that composed of about twenty-five individuals in all, and they not more than eighteen inches in height. In the moist vleis, on the other hand, some of the grasses—species of *Andropogon*—would be eight and even ten feet in height. In the absence of woody plants Kaffir and Boer alike fall back on 'mist,' *i. e.,* dried ox-dung, for fuel.

Grasses being, as I have said, the most conspicuous feature of the high veldt flora, one is naturally desirous of knowing what grasses occur, and in particular, which are the most abundant.

Although but little work has been done on the flora of the Transvaal, as compared with that done on the flora of California, for instance, a few good collections have been made, particularly by Wilms Rehmann, Nelson, Galpin and Rand, and sufficient grass material has been gathered by the three first named collectors to give a general idea of the occurrence of the genera. Much still remains

to be done, as my winter's collection of grasses shows, in working out the distribution of genera and species and the relative abundance and economic value of species and individuals. It is almost inevitable that a large number of additional species and some genera will be found, for whole districts of great size and varied climatic and edaphic conditions remain wholly untouched by the botanist.

A reference to Dr. Stapf's masterly enumeration of the Gramineæ, in Vol. VII. of the 'Flora Capensis,' shows that there are some 130 species of grasses recorded as occurring in the Transvaal. These represent 50 genera, or less than half of the 103 genera recorded for the whole South African flora, which includes the desert region of the Karroo and the subtropical coast region of Natal. Of these 50 genera, 44 are represented by species apparently indigenous, four—*Arundo*, *Poa*, *Bromus* and *Lolium*—by species certainly alien, while two, *Eleusine* and *Dactyloctenium*, may perhaps be considered doubtfully indigenous.

The limited number of alien species (only about seven) is remarkable as compared with the number found in such new countries as Cape Colony and California. This is due not only to the isolation of the Transvaal, with no coast-line and separated from the Cape by the Karroo, from the Atlantic coast by the Kalahari, and from the Natal coast by the Drakensberg, but also perhaps largely to the fact that so little intercourse has been held between its inhabitants and those of adjacent regions.

Fortunately for the horticulturist, all kinds of alien weeds are at present scarce.

This state of things can not be expected to last much longer, however, and we shall look for several more alien genera of grasses, with many additional species, to become naturalized within a short period. Judging by analogy, and with the instance of the plateau stock-ranges of the Pacific states of North America fresh in mind, it can scarcely be otherwise. With the introduction of thousands of head of cattle from Cape Colony, Madagascar, Europe and Texas, and of thousands of bags of seed-grain from Texas, Argentina, Algeria, Europe and Cape Colony, it would be remarkable if aliens were not largely introduced. Already at least two species of grasses, *Poa annua* and *Sorghum halepense*, have become naturalized in the Transvaal, apparently in the short time since the most recent of the material embodied in Dr. Stapf's paper was collected.

The following species, already established in South Africa, are to be expected as additions to the alien flora of the Transvaal, before very long: *Lolium multiflorum*, *Hordeum murinum*, *Bromus maximus*, *Bromus commutatus*, *Bromus arvensis*, *Bromus patulus*, *Vulpia myuros*, *Vulpia bromoides*, *Briza minor*, *Briza maxima*, *Dactylis glomerata*, *Aira caryophyllea*, *Holcus lanatus*, *Cynosurus echinatus*, *Lamarckia aurea*, *Phalaris minor*, *Tragus racemosus*, *Panicum crus-galli*, *Avena fatua* and *Avena sterilis*.

Far more remarkable and interesting than the scarcity of alien grasses is the distribution of the fifty genera among the eighteen tribes of Dr. Stapf's classification. One of the most interesting points is the fact that nineteen of the genera belong to the two closely related tribes Andropogoneæ and Paniceæ; of the eleven South African genera of Andropogoneæ and eleven genera of Paniceæ, ten and nine respectively are represented by species indigenous to the Transvaal. Of the tribe Chlorideæ, nine of the twelve South African genera are represented, while all of the four genera of Eragrosteæ and the three of Arundinelleæ occur.

On the other hand, we find that the tribe Aveneæ, with thirteen genera in South Africa, is represented in the Transvaal collections by a *single species* only. The Hordeæ with five genera, the Agrosteæ with four, the Phalarideæ and Bambuseæ with two, the Phareæ with one, are not represented by a single indigenous species, while the large tribe Festuceæ, with twenty genera (eighteen indigenous and two alien), has only four native genera and five native species, with two alien genera and two alien species. The Stipeæ, with three genera, is represented by only one,

Aristida, but of this there are ten species recorded from the region.

To gain a general idea of the grass flora of the Transvaal, it is well to note the genera containing the largest number of species. We find the following figures:

Eragrostis	has	23	species.
Andropogon	"	16	"
Panicum	"	12	"
Aristida	"	10	"
Setaria	"	6	"
Trichopteryx	"	4	"
Pennisetum	"	4	"
Sporobolus	"	4	"
Digitaria	"	3	"
Microchloa	"	3	"

Seven genera have only two species each.

Thirty-four genera are only represented by a single species. These include the well-known North American genera *Paspalum*, *Bromus* and *Poa*, all three represented by alien species. It is probable that native species of *Paspalum* will be found in some parts of the Transvaal.

In these notes I have used the word species in a broad sense, for convenience, enumerating as species some of Dr. Stapf's varieties.

Of the four largest genera, three—*Andropogon*, *Panicum* and *Aristida*—are well known to North American botanists, being prominently represented in the North American grass flora. With the exception of this apparent connection, which may not be as real as apparent, there is little or no relationship between the two floras.

Certain well-known North American genera, such as *Rottbaellia, Stenotaphrum, Kœleria, Trisetum, Avena, Danthonia, Agrostis, Calamagrostis, Stipa, Oryzopsis, Tragus, Spartina, Phalaris, Melica, Panicularia Puccinellia, Festuca, Poa, Bromus, Lepturus, Agropyron* and *Hordeum*, all of which occur in South Africa, are not represented by a single species indigenous to the Transvaal, and only two of these, *Poa* and *Bromus*, by alien species.

Three of the largest genera of South African grasses, *Danthonia* with twenty-five species, *Ehrharta* with twenty-five and *Pentaschistis* with thirty-eight, have not, so far, been found in the Transvaal collections.

With regard to the relative proportion of individuals, a very rapid reconnoissance of the high veldt made during early winter before the grasses had lost their inflorescences, showed that *Andropogons*, and perhaps in places *Anthistirias*, are the most characteristic grasses throughout the high veldt. Other genera are represented by scattered individuals or by relatively small colonies restricted by peculiar edaphic conditions.

From what little I have so far seen of the bush veldt and the low country, it would appear that grasses are almost as abundant there as on the high veldt, but there they cease to form so characteristic a feature of the vegetation because of the abundance and prominence of the bushes and trees.

Bermuda grass (*Capriola dactylon*) is widely distributed along roadsides, in lawns, in cattle kraals and on town lands where the oxen are outspanned, but it does not have the aspect of an indigenous grass. On the open veldt it is usually found at outspanning places, and covering old and deserted ant-heaps, but the patches are rarely connected. It is highly valued as a pasture grass and is closely eaten down by mules. The Boers state that it is readily introduced into the veldt by grazing closely with sheep.

The reed (*Phragmites vulgaris*) is common along almost every stream that I have crossed, from the sources of the Limpopo on the high veldt to the Mooi, Malmanie and Marico in the west, not far from Mafeking, and to the falls of the Koomatie at Koomatiepoort on the frontier of Portuguese East Africa. It has been called a distinct species by some writers, but Dr. Stapf does not consider it worthy of even varietal rank.

The adaptation of the vegetation to peculiar climatic conditions—a literally rainless winter season of four to five months (May to September inclusive) and a fair rainfall (twenty-five to thirty inches) during the rest of the year—is interestingly demonstrated by the development of the bulb-, corm- and tuber-producing habit. This is not confined to the families Amaryllidaceæ and Iridaceæ (which are well

represented), but extends to a remarkable extent to the Asclepiadaceæ and also to the Leguminosæ; probably other families are also affected. It seems likely that in the Transvaal this development enables the plant the better to survive adverse temporarily xerophytic conditions. It is particularly noticeable here that these plants are among the first to flower in the spring, and that many—I am not yet able to say with certainty, most—of them flower without a drop of rain having fallen for four or five months, and on dry hillsides where they are not affected by any subirrigation. It is true that there has been some heavy dew, but in some of these instances not enough to make the grasses and annuals start growth. As I write there are Liliaceæ, Iridaceæ and Asclepiadaceæ in bloom on some of the driest ridges of the high veldt, where scarcely a new blade of grass is to be found. It must not be inferred from this, however, that there is no green grass at this season. On areas of burned veldt the new growth of grass is in many cases quite perceptible even without any rain, perhaps owing to the effect of heavy dews.

JOSEPH BURTT DAVY.

BRAIN-WEIGHTS OF BROTHERS.

IN a former number of SCIENCE (XVII., No. 430, p. 516) the writer cited several brain-weights of brothers and sisters, mostly children. After the recent execution by electricity of the three Van Wormer brothers, the following data were obtained at the post-mortem examination:

	Willis.	Burton.	Fred.
Age	27	23	21
Stature (centimeters)	172.8	178.0	175.2
Head length	18.2	19 1	19.1
Head breadth	15.1	15 1	16.0
Cephalic index	82.9	79.0	83.7
Head circumference	53.3	54.1	56.1
Body-weight (estimated)	140 lbs.	145	150
Fresh brain-weight	1,340 gms.	1,358	1,600

The high weight of Frederick's brain occasioning some comment, it was again weighed after about five minutes' drainage, the second figure being 1,590 gms. The left hemicerebrum weighed 3 gms. more than the right in Willis's and 10 gms. less in Burton's, while in Frederick's case the two halves weighed exactly the same.

The physiognomy of the cerebral gyral conformation of the three brains is quite similar in some respects.

A full report will be published later. There was a well-marked postorbital limbus on the left side in Frederick's brain.

E. A. SPITZKA, M.D.

RECENT ZOOPALEONTOLOGY.

SCHLOSSER'S LITERATURBERICHT.

DR. MAX SCHLOSSER, of Munich, continues his invaluable 'Literaturbericht' up to the close of the year 1900, and sends it to us as an abstract from the *Archiv für Anthropologie*, Bd. XXVIII. Like all the previous numbers of this review, which began in 1883, this is most welcome not only because our attention through it is directed to the entire literature, but because of the original critical notes which the author adds to the various abstracts which he presents.

AMERICAN OLIGOCENE MICROFAUNA.

IN the White River formation near Pipestone Springs, western Montana, Mr. Earl Douglass discovered a very interesting microfauna. The American Museum of Natural History in 1902 visited the same locality and secured a rich collection of small mammals, especially important because the *Titanotherium* beds of South Dakota have yielded only the large mammals of the period. The collection is described by Dr. W. D. Matthew* as including one marsupial allied to *Didelphys,* three Insectivora, including two new genera of an extremely primitive type, two species of Creodonta, two of Carnivora related to the dogs and mustelines respectively and six species of rodents. Among the horses is the primitive *Mesohippus westoni,* older in type than *Mesohippus bairdi.* The Artiodactyla are also represented by a variety of small forms. In this connection may also be

* 'The Fauna of the *Titanotherium* Beds of Pipestone Springs, Montana,' *Bull. Amer. Mus. Nat. Hist.*, Vol. XIX., 1903, art. VI., pp. 197–226.

mentioned the small fauna of the lower Pleistocene which has been found in caves of California and in fissure deposits in northern Arkansas, which promise to give us a nearly complete knowledge of the Lower Pleistocene microfauna of North America.

TRIASSIC REPTILIA.

The comparatively little known Reptilia of the Trias are now receiving more attention. Von Huene* has published in *Palæontographica* quite an elaborate review of all the Triassic reptiles, including also the large amphibian Stegocephala of the Lower Trias as well as the South African forms.

Dicynodonts.—Dr. R. Broom† is contributing a series of very important papers on the South African Dicynodonts. One of the first of these, on the structure and affinities of *Udenodon,* appeared in 1901. In this genus as well as in *Dicynodon* he finds marked sexual characters or differences between the supposed males and females in the structure of the canine teeth and the massiveness of the lower jaw.

Theriodonts.—Among the Theriodonts the same author‡ finds two widely different types of palatal structure and he selects *Scylacosaurus* as the type of a new order, Therocephalia, to include the most primitive of the Theriodonts. It is possible that the higher typical Theriodonts, such as *Galesaurus* and *Cynognathus,* are descended from the Therocephalians; but the gap between the two is very great.

From Aliwal North he records§ a very surprising discovery of the lower jaw of a small mammal which is named *Karoomys Browni,* probably the oldest mammalian jaw which has yet been discovered. The jaw, although of greater geological age, remotely suggests that of *Microconodon* from our Upper Triassic. The angle is well developed and but very slightly inflected. The author considers that its nearest allies are probably to be found among the Jurassic forms, such as *Diplocynodon* Marsh.

Vomer and Prevomer.—Another paper by the same author on the mammalian and reptilian vomerine bones* advances the theory that the true vomer in mammals is represented by the parasphenoid of Huxley, a very large element in the Ichthyopsida and reduced or wanting in the Sauropsida. It is maintained further that the so-called vomers of reptiles are entirely distinct elements, to which the name 'prevomer' should be given. These are represented by the 'dumb-bell bone' of Monotremes, and by vestigial elements in Cheiroptera. The true mammalian vomer is a single median element developed between the united trabeculæ, while the Sauropsidan prevomer is a paired element formed in connection with the nasal capsules. Both elements exist in the Amphibia, and in general the prevomers are enlarged and the vomers reduced in Reptilia, while in Mammalia the prevomers are reduced and the vomers enlarged.

The same author† transfers the genus *Procolophon,* which has always been considered related to the solid-skulled Cotylosauria, to a group related to *Sphenodon* with two distinct temporal arches.

CRETACEOUS REPTILES.

Mosasaurs.—Baron Franz Nopcsa, Jr.,‡ traces the great marine lizards, or Mosasaurs, back to the Aigialosaurs, which differ from Mosasaurs only in not being so thoroughly adapted to pelagic life. These reptiles, which were found in the Lower Cretaceous of Dal-

*'Uebersicht über die Reptilien der Trias,' *Palaeontographica*, 1902, pp. 1–84, tab. I.–IX.

†'Remarks on Certain Differences in the Skulls of Dicynodonts, Apparently due to Sex,' *Proc. Zool. Soc. Lond.*, June 3, 1902.

‡'On the Structure of the Palate in the Primitive Theriodonts,' *Geol. Mag.*, Decade IV., Vol. X., No. 470, August 1903.

§'On the Lower Jaw of a Small Mammal from the Karoo Beds of Aliwal North, South Africa,' *Geol. Mag.*, December IV., Vol. X., No. 470, August, 1903.

*'On the Mammalian and Reptilian Vomerine Bones,' *Proc. Linnean Soc. of New So. Wales*, 1902, Pt. 2, October 29.

†'On the Remains of *Procolophon* in the Albany Museum,' *Records of the Albany Museum*, Vol. I., No. 1, p. 8.

‡'On the Origin of the Mosasaurs,' *Geol. Mag.*, Decade IV., Vol. X., No. 465, p. 119, March, 1903.

matia, show a strong relationship to the living monitor lizards, differing from them only in those adaptive features in which they approach the Mosasaurs. Still farther back he hypothecates a terrestrial Jurassic type, of which the Cretaceous Mosasaurs and recent Monitors are the offspring. The author was not aware that Dr. Louis Dollo,* of Brussels, had already presented a similar theory in 1892—apparently another case of independent discovery. Baron Nopcsa has presented also recently a number of interesting memoirs upon the Iguanodontia.

Plesiosaurs.—After having exhaustively studied the North American Mosasaurs, Professor S. W. Williston has begun to monograph the North American Plesiosaurs, his first complete paper, 'North American Plesiosaurs, Part I.,' appearing from the Field Columbian Museum last April. This part is devoted first to an exhaustive description of the remarkably preserved type *Dolichorhynchops osborni* discovered by Sternberg in the chalk of Logan County, Kansas, and now mounted in the museum of Kansas University. Its most distinctive feature is the great elongation of the snout correlated with a relatively abbreviated neck. The author finds that the Plesiosaurs, like the Mosasaurs, were divided into a number of independent but contemporaneous phyletic series, the distinctive characters of which are chiefly found in the structure of the shoulder girdle, in the proportions of the neck and of the skull. All the Plesiosaur materials in the American Museum of Natural History have been placed at the author's disposal for study, and the Carnegie Institution has made a special grant for the continuation of this research.

JURASSIC REPTILES.

Compsognatha.—Franz v. Nopcsa† has restudied the type and other specimens of *Compsognathus* from the Jurassic of Solenhofen. He has made a special examination of the so-called 'embryo' discovered by Marsh in the body cavity of the Munich type; and he comes to the conclusion that this supposed embryo is the skeleton of a small lizard. Osborn* has recently described a supposed bird-catching Dinosaur found in the Como beds of Wyoming and now mounted as a remarkably complete skeleton in the collection of the American Museum of Natural History. This type probably belongs to the same subdivision of the Carnivorous Dinosaurs as *Compsognathus,* namely, the Compsognatha of Huxley, distinguished by hollow vertebræ in contrast with the solid hour-glass-shaped vertebræ of the Megalosauria. *Ornitholestes* is particularly distinguished by three very long, slender fingers on the manus, the other fingers being reduced, hence the supposition that it was adapted to grasping a slender and agile prey such as the Jurassic birds.

Sauropoda.—Our knowledge of the Sauropoda, or amphibious Dinosaurs, is being enriched by descriptions of remarkably complete specimens of *Brontosaurus* in the Field Columbian, Carnegie and American Museums. Dr. E. S. Riggs has briefly described the former and is now preparing an elaborate paper. Mr. J. B. Hatcher is describing the Carnegie Museum skeleton. In the American Museum of Natural History, an exceptionally large skeleton of *Brontosaurus,* discovered in 1898, is being restored and mounted complete. In the Yale University Museum the pelvis and hind limbs of the still more perfect type skeleton of *B. excelsus* have recently been mounted under the direction of Professor C. E. Beecher.

Mr. Hatcher† shows that *Pleurocœlus nanus* Marsh, the smallest of the Sauropoda, is identical with *Astrodon johnsoni* Leidy, and is closely related, as Marsh pointed out, to remains found in Jurassic deposits near Havre, Normandy.

* 'Les Ancêstres des Mosasauriens,' *Bulletin Scientifique de la France et de la Belgique,* extr. du Tome XXXVIII.

† 'Neues über *Compsognathus,*' Sep.-Abdr. a. d. *Neuen Jahrb. f. Miner., Geol. u. Palaeont.,* Beilage-Band XVI., 1903, S. 476–494.

* '*Ornitholestes hermanni,* a New Compsognathoid Dinosaur from the Upper Jurassic,' *Bull. Amer. Mus. Nat. Hist.,* Vol. XIX., 1903, art. XII., pp. 459–464.

† 'Discovery of Remains of *Astrodon* (*Pleurocœlus*) in the Atlantosaurus Beds of Wyoming,' *Ann. Carnegie Museum,* Vol. II., 1903, pp. 9–14.

From the famous quarry of Cañon City, Colorado, the same author* describes a new Sauropod, *Haplocanthus priscus,* distinguished by simple neural spines in the posterior cervical and anterior dorsal vertebræ, thus totally unlike either *Camarasaurus, Brontosaurus* or *Diplodocus.* The author regards it as the most generalized member of this order yet discovered in America, but that it is a member of this order he believes is clearly shown in the structure of the pelvis and by other characters exhibited by the vertebræ, its nearest affinities being to the Morosauridæ.

H. F. O.

SCIENTIFIC NOTES AND NEWS.

The following is a list of those to whom the Royal Society has this year awarded medals: The Copley medal to Professor Eduard Suess for his eminent geological services, and especially for the original researches and conclusions published in his great work 'Das Antlitz der Erde.' A royal medal to Sir David Gill for his researches in solar and stellar parallax, and his energetic direction of the Royal Observatory at the Cape of Good Hope. A royal medal to Mr. Horace T. Brown for his work on the chemistry of the carbohydrates and on the assimilation of carbonic acid by green plants. The Davy medal to M. Pierre and Madame Curie for their researches on radium. The Hughes medal to Professor Wilhelm Hittorf for his long continued experimental researches on the electric discharge in liquids and gases.

Lord Kelvin received the degree of D.Sc. from the University of Wales on the occasion of the Court of November 13.

The Royal Asiatic Society has conferred its triennial medal on Sir William Muir, lately principal of the University of Edinburgh.

Dr. Henry S. Pritchett, president of the Massachusetts Institute of Technology, has resumed his official duties after a brief foreign visit.

* 'A New Sauropod Dinosaur from the Jurassic of Colorado,' J. B. Hatcher, *Proc. Biol. Soc. Washington,* February 21, 1903, Vol. XVI., pp. 1–2.

Professor Geo. F. Atkinson, of Cornell University, returned to America on November 14, after having made a study of fungi in various European collections.

Dr. L. McI. Luquer, of the department of mineralogy of Columbia University, has obtained leave of absence and will sail for Europe early in February.

Dr. R. D. Murray, of the U. S. Marine Hospital Service, who has been at Laredo, Texas, combating the epidemic of yellow fever, has been seriously injured as the result of a runaway accident.

Mr. Ambrose Swasey, of Cleveland, Ohio, has been nominated for president of the American Society of Mechanical Engineers. The society will hold its annual meeting in New York, beginning on December 1, when the president, Mr. James M. Dodge, will deliver the annual address, the subject being 'The Value of an Engineering Education to a Young Man.'

Mr. R. K. Kaye Gray gave the presidential address before the British Institution of Civil Engineers on November 12.

Dr. Otto Augustus Wall has completed his thirtieth year as professor of materia medica and botany in the St. Louis College of Pharmacy. On the evening of November 14, the graduates of the institution presented the college with a life-size medallion of Professor Wall, and a duplicate medallion was presented to his family. The presentations were accompanied by appropriate exercises, followed with a banquet tendered Professor Wall by the Alumni Association.

Professor W. M. Scott, formerly state entomologist (and pathologist) of Georgia, Atlanta, Ga., has resigned to accept a position as pathologist in the Bureau of Plant Industry, U. S. Department of Agriculture. He has already entered upon his new duties, which relate to diseases of orchard fruits. Professor Wilmon Newell, formerly of Iowa, recently of the Texas Agricultural College, has been appointed as state entomologist of Georgia to fill the vacancy caused by Professor Scott's resignation.

DR. CHARLES J. MARTIN, F.R.S., formerly professor of physiology at the University of Melbourne, who was appointed director of the Lister Institute of Preventive Medicine some months ago, has now taken up his duties.

MR. WILLIAM ROSCOE THAYER has undertaken, at the request of Mr. Fiske's family, to edit the letters of the late John Fiske. He earnestly requests that persons having any of Mr. Fiske's letters will send them, or copies of them, to No. 8 Berkeley St., Cambridge, Mass.

A LECTURESHIP has been endowed in the University of Birmingham by an anonymous friend in memory of the life and work of the late Professor Huxley. Sir Michael Foster has been invited to give the first lecture.

A PROJECT has been started to found at Peterhouse, Cambridge, a prize for physics in memory of Professor Tait, of Edinburgh, for many years a fellow, and at his death an honorary fellow, of the college.

THE weekly assembly exercises of November 18 at the State University of Iowa were devoted to a memorial service in honor of Dr. Frank Russell, of Harvard University, whose untimely death we have recorded. Impressive addresses were delivered by Dr. Samuel Calvin, Professor A. G. Smith and Professor C. C. Nutting. A letter was also read from Professor F. W. Putnam, of the Peabody Museum. Dr. Russell was a graduate of the University of Iowa with the class of 1892 and conducted his first scientific explorations in the far north under the auspices of that institution.

DR. HENRY CARRINGTON BOLTON, well known as a chemist and bibliographer, died at Washington on November 19 in his sixty-first year.

PROFESSOR ARTHUR ALLIN, B.A. (Toronto), Ph.D. (Berlin), since 1897 head of the Department of Psychology and Education in the University of Colorado, at Boulder, died on November 17, of typhoid fever. Dr. Allin had given much time recently to the study of sociological problems viewed from the psychological standpoint.

DR. GEORGE J. ENGELMANN, of Boston, an eminent physician and gynecologist, son of the well-known botanist, died on November 16 from pneumonia at the age of fifty-six years.

MR. J. STANLEY GRIMES, a writer and lecturer on scientific subjects, especially on the physiology of the brain, died at Evanston, Ill., on October 1, at the age of ninety-six years. Mr. Grimes had been a fellow of the American Association for the Advancement of Science since 1874.

WE regret also to record the deaths of Sir Charles Nicholson, Bart., who practised medicine in Sydney, and was the first chancellor of the University of Sydney, on November 8, in his ninety-fifth year; of Dr. Nabel, professor of geodesy in the Technological Institute of Dresden, aged eighty-three years; of Dr. Otto Nasse, formerly professor of physiological chemistry in the University of Rostock, at the age of sixty-four years, and of Dr. G. R. Dahlander, professor in the Technological Institute of Stockholm.

DR. GEORGE R. TABOR, Texas State Health Officer, proposes to extend invitations to Surgeon General Wyman and the representatives of the Health Departments of Louisiana, Mississippi and Alabama to accompany him to Mexico next January for the purpose of holding a conference with the Superior Board of Health of that country to determine upon a concerted plan of action that would prevent another epidemic of yellow fever in Mexico and the spread of the disease to Texas and the south.

THE scientific mission under the charge of Drs. Todd and Dutton, which has been despatched to Central Africa under the auspices of the Liverpool School of Tropical Medicine, has arrived at Boma. The object of the mission is to study the pathology of various tropical maladies, including sleeping sickness.

The British Medical Journal states that Lieutenant-Colonel Bruce, F.R.S., who returned from Uganda some weeks ago, has established by experiments conducted in conjunction with Dr. Nabarro and Captain Grieg, I.M.S., two important points. The first is that monkeys inoculated with the cerebrospinal fluid of patients suffering from sleeping sickness, or with blood from natives not yet

showing the symptoms of the disease, but containing a similar parasite, subsequently present all the symptoms of the disease; the second is that the disease is limited to districts of South Africa within which the particular tsetse fly, *Glossina palpalis*, occurs, and that where this fly does not occur sleeping sickness is absent. The evidence, therefore, to connect sleeping sickness, with the presence of trypanosomes in the cerebro-spinal fluid is now apparently very strong.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. John D. Rockefeller has offered to give Vassar College $200,000, or such part of this sum as may be equaled by gifts from other sources before June 1904. $50,000 has so far been subscribed, and an appeal is made for further gifts.

The building of the Medical Department of Northwestern University was injured by fire on November 20, the loss being estimated at $10,000.

The Association of Colleges and Preparatory Schools of the Middle States and Maryland will hold its seventeenth annual convention at Columbia University, New York, on November 27 and 28. Dr. Ira Remsen, president of the Johns Hopkins University and of the association, will give an address entitled 'Some Unsolved Educational Problems.' The subjects for discussion are 'The Elective System and Secondary Schools,' 'What Should be the Length of the College Course?' and 'Athletics in Schools and Colleges.' On Saturday an Association of Mathematicians of the Middle States and Maryland will be organized.

It is reported that there is an outbreak of typhoid fever both at Brown University and at Williams College.

The University of Liverpool was formally inaugurated on November 7. Addresses were made by the Lord Mayor of Liverpool, Lord Derby, Vice-chancellor Dale and Sir Oliver Lodge.

A memorial has been addressed to the General Board of Studies at Cambridge urging that increased opportunities for study in anthropology be offered at the university.

Professor John A. Brashear has resigned the chancellorship of the Western University of Pennsylvania.

President Howard Ayres, for the last four years president of the University of Cincinnati, has been deposed from that office by a majority vote of the board of trustees. He will retain the position until the close of the academic year.

The following appointments have recently been made in the Massachusetts Institute of Technology: Leslie Rogers Moore, S.B., Arthur Alphonzo Blanchard, Ph.D., Livingston W. Smith, Ph.D., instructors in inorganic chemistry; Frank Baldwin Jewett, Ph.D., William Otis Sawtelle, S.B., instructors in physics; Percy Goldthwaite Stiles, Ph.D., instructor in physiology and personal hygiene; Wilfrid Evart MacDonald, A.B., Burton H. Camp, A.B., instructors in mathematics; Eugene Stillman Foljambe, S.B., James Russell Putnam, S.B., instructors in mechanical drawing and descriptive geometry; Winfield C. Towne, A.B., instructor in gymnastics.

Dr. J. N. Langley, F.R.S., fellow of Trinity College, has been elected to the professorship of physiology at the University of Cambridge, vacant by the resignation of Sir Michael Foster.

The board of Trinity College has elected Dr. Sydney Young, F.R.S., Dublin, professor of chemistry in University College, Bristol, to the chair of chemistry vacant by the resignation of Professor Emerson Reynolds.

Dr. W. G. Smith, M.A., who was appointed last year to the recently established lectureship on experimental psychology at King's College, London, has resigned to accept a similar position at the University of Liverpool. The council of King's College has elected to the post Dr. C. S. Myers, M.A., of Cambridge. Dr. Smith was some time since instructor at Smith College, and Dr. Myers has recently visited the psychological laboratories of the United States.

Dr. Wilhelm Wörtinger, of Innsbruck, has been appointed professor of mathematics in the University of Vienna, and Dr. A. Partheil, associate professor of chemistry at Bonn, has accepted a similar position of Königsberg.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 4, 1903.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE fifty-third annual meeting of the American Association for the Advancement of Science, and the second of the convocation week meetings, will be held in St. Louis, Mo., on December 28, 1903, to January 2, 1904.

A meeting of the executive committee of the council (consisting of the general secretary, the secretary of the council, the permanent secretary, and the secretaries of all of the sections), will be held at the office of the permanent secretary, in the Southern Hotel, Broadway and Walnut Sts., at noon on Saturday, December 26.

The opening session of the association will be held at 10 o'clock A.M., on Monday, December 28, in the auditorium of the Central High School building.

A railway rate for one and one third on the certificate plan has been granted by several railways, and it is expected that this rate will be granted by all the railways of the country.

The headquarters of the association will be at the Southern Hotel, and the Planters Hotel will be selected as headquarters for some of the affiliated societies.

For further matters relating to the local arrangements, transportation and hotel and boarding-house accommodations, address the local secretary, Professor A. S.

Langsdorf, Washington University, St. Louis, Mo.

For information relating to the presentation of papers, members should address the secretaries of the respective sections. Titles and abstracts of papers should be sent promptly to the secretaries, or to the permanent secretary. Blank forms upon which abstracts may be filled out will be forwarded. The post-office addresses of the several secretaries are given in the list of officers following this general announcement.

Nominations to membership and letters relating to the general business of the association should be sent to the permanent secretary at the address given herewith. It is strongly urged that each member reading this announcement should at least make an effort to secure the nomination of some desirable new member.

Members paying their dues before December 20 will receive their tickets by mail at once, and will thus save time in registering on their arrival at St. Louis, provided they bring their tickets with them.

The register for the St. Louis meeting will be open at 10 A.M., on Saturday, December 26, at the general office of the local and permanent secretaries in the Central High School Building.

L. O. Howard,
Permanent Secretary, Cosmos Club, Washington, D. C.

Officers for the meeting are as follows:

President: Carroll D. Wright, Commissioner of Labor, Washington, D. C.

Vice-Presidents: (A) *Mathematics and Astronomy*—Otto H. Tittmann, Coast and Geodetic Survey, Washington, D. C. (B) *Physics*—E. H. Hall, Harvard University, Cambridge, Mass. (C) *Chemistry*—W. D. Bancroft, Cornell University, Ithaca, N. Y. (D) *Mechanical Science and Engineering*—C. M. Woodward, Washington University, St. Louis, Mo. (E) *Geology and Geography*—I. C. Russell, University of Michigan, Ann Arbor, Mich. (F) *Zoology*—Edward L. Mark, Harvard University, Cambridge, Mass. (G) *Botany*—T. H. MacBride, University of Iowa, Iowa City, Iowa. (H) *Anthropology*—M. H. Saville, American Museum of Natural History, New York, N. Y. (I) *Social and Economic Science*—Simeon E. Baldwin, New Haven, Conn. (K) *Physiology and Experimental Medicine*—H. P. Bowditch, Harvard University, Cambridge, Mass.

Permanent Secretary: L. O. Howard, Cosmos Club, Washington, D. C.

General Secretary: Ch. Wardell Stiles, Public Health and Marine Hospital Service, Washington, D. C.

Secretary of the Council: Charles S. Howe, Case School, Cleveland, Ohio.

Secretaries of the Sections: (A) *Mathematics and Astronomy*—L. G. Weld, University of Iowa, Iowa City, Iowa. (B) *Physics*—Dayton C. Miller, Case School, Cleveland, Ohio. (C) *Chemistry*—C. L. Parsons, New Hampshire College, Durham, N. H. (D) *Mechanical Science and Engineering*—Wm. T. Magruder, Ohio State University, Columbus, Ohio. (E) *Geology and Geography*—G. B. Shattuck, Johns Hopkins University, Baltimore, Md. (F) *Zoology*—C. Judson Herrick, Denison University, Granville, Ohio. (G) *Botany*—F. E. Lloyd, Teachers' College, Columbia University, New York, N. Y. (H) *Anthropology*—Geo. H. Pepper, American Museum of Natural History, New York, N. Y. (I) *Social and Economic Science*—J. F. Crowell, Bureau of Statistics, Washington, D. C. (K) *Physiology and Experimental Medicine*—Frederic S. Lee, Columbia University, New York, N. Y.

Treasurer: R. S. Woodward, Columbia University, New York, N. Y.

The local committee includes:

Honorary President: David R. Francis.

President: William Trelease.

Vice-Presidents: First Vice-President, C. M. Woodward. Second Vice-President, F. Louis Soldan. Third Vice-President, R. H. Jesse.

Treasurer: William H. Thomson.

Secretary: Alexander S. Langsdorf.

Executive Committee: William Trelease, Chairman; Geo. H. Morgan, Secretary; William H. Thomson, Treasurer; W. S. Chaplin, A. S. Langsdorf, F. E. Nipher, John Schroers, Walter B. Stevens, William Taussig, H. C. Townsend.

PRELIMINARY PROGRAM.

At the first general session, to be held at 10 A.M., the meeting will be called to order

by the retiring president, Dr. Ira Remsen, who will introduce the president-elect, the Hon. Carroll D. Wright, and short addresses of welcome and announcements will be made. The retiring president will give his address at the Odeon in the evening, and in the afternoon the addresses of the retiring vice-presidents will be given, as follows:

At 2:30 P.M.

Vice-president Halsted before the Section of Mathematics and Astronomy.

Vice-president Baskerville before the Section of Chemistry.

Vice-president Davis before the Section of Geology.

Vice-president Dorsey before the Section of Anthropology.

At 4 P.M.

Vice-president Nichols before the Section of Physics.

Vice-president Waldo before the Section of Mechanical Science and Engineering.

Vice-president Hargitt before the Section of Zoology.

Vice-president Coville before the Section of Botany.

Vice-president Newcomb before the Section of Social and Economic Science.

The sections will meet daily immediately after the adjournment of the general session, and from that time until one o'clock, and then after an intermission of one hour for luncheon, from two to five, except on Thursday afternoon which will be devoted to a visit to the exposition grounds. For details the daily programs, to be had of the local secretary and in the section rooms, should be consulted.

Though other evening sessions may be announced later, the local committee now has knowledge of only the following evening events:

Monday Evening.—The retiring president of the association, President Ira Remsen, of the Johns Hopkins University, will deliver his address in the Odeon, at the corner of Grand and Finney Avenues, at eight o'clock. The subject, which will be of general interest, will be announced later. The public are invited to attend.

Tuesday Evening.—Sections D and F are likely to hold evening sessions.

The American Association and the American Society of Naturalists hope to secure a lecture, complimentary to the citizens of St. Louis, on a subject of general interest and by a speaker of international reputation, in the auditorium of the Central High School, at eight o'clock; if so due announcement will be made.

At nine o'clock the American Society of Naturalists and affiliated societies will hold their annual smoker at the University Club, Grand and Washington Avenues.

Wednesday Evening.—Section D is likely to hold an evening session.

The retiring president of the American Chemical Society, Dr. John H. Long, will deliver his address in Room 102, at 7:30 o'clock. His subject is 'Some Problems in Fermentation.'

The annual election of the American Society of Naturalists will be held at the Mercantile Club, Seventh and Locust Streets, at 6:45. At seven o'clock, in the same place, will be given the annual dinner of the society, followed by the address of the retiring president, Professor William Trelease. Members of this society and of the societies affiliating with it are requested to register for the dinner as soon as possible after reaching the city, at the desk of the local secretary, who will receive payment for and issue tickets—to be taken up at the dinner.

Thursday Evening.—The regular meeting of the general committee of the association, consisting of the council and one member from each section, will be held at the hotel office of the permanent secretary, at the Southern Hotel, at eight o'clock, to elect officers and decide upon the time and place of the next meeting.

The annual banquet of the Sigma Xi

Honorary Scientific Society will be given at the Mercantile Club, Seventh and Locust Streets, at seven o'clock. The banquet will be followed by an address by President David Starr Jordan, of the Leland Stanford Junior University. Members are requested to register and procure tickets for the banquet, at the desk of the local secretary, as soon as possible after arriving in St. Louis.

Friday Evening.—The fourteenth banquet to the Trustees of the Missouri Botanical Garden and their guests, provided for in the will of the founder of the garden, will be given at an hour and place to be announced later.

ENTERTAINMENTS.

In providing entertainment for their scientific guests, the local committee has tried to avoid interference with the regular sessions of the association and affiliated societies, and the season of the year at which the meeting is held and the need of a prompt return to their university duties felt by most of their guests have prevented the committee from planning for excursions such as they would have found pleasure in providing under other circumstances. They take pleasure, however, in announcing the following features, which will be more fully detailed in the daily programs.

By invitation of the officers of the Louisiana Purchase Exposition, members of the association and affiliated societies will, on one of the days of their meeting, proceed in specially provided cars to the World's Fair grounds, immediately after the noon adjournment. On the grounds, they will be tendered a buffet luncheon by the officers of the exposition, after which, in parties of suitable size, they will be taken through the buildings and shown the progress of installation of the exhibits under the personal charge of the chiefs of departments, under whom the installation is being made.

The chemists are invited to visit the great breweries, either in a body or as individuals, and promised every courtesy in inspecting these and other features of interest to them.

The geologists will receive every possible courtesy from the managers of the smelting and similar establishments of the city which they may find it possible to visit, and it is probable that those who care to do so will have the privilege of visiting the great lead mines of southeastern Missouri, if they can spare a day for this purpose.

The engineers will be enabled to visit the historical Eads Bridge over the Mississippi River, the pumping plant and settling basins furnishing the city water supply, and other points of interest to them, as well as the engineering features of the exposition, of which a special study will be made.

The botanists are invited to visit the Missouri Botanical Garden, either in a body or individually, and are promised every aid that can make their visit pleasurable or profitable.

In addition to the address by the president of the American Association, to be given in the Odeon on Monday evening, it is expected that one other public lecture, complimentary to the citizens of St. Louis will be delivered on another evening by a speaker of international reputation on a subject of both scientific and general interest.

The entertainment committee proposes to furnish luncheon in the high school building, so that members may meet together and without being under the necessity of leaving the building for this purpose. It is expected that courtesies will be extended by a local ladies' club to ladies in attendance at the meetings, and the city clubs, the trustees of the Missouri Botanical Garden, the Academy of Science, and other

local organizations will do what is in their power to make the week a pleasant one to those who attend the meetings.

AFFILIATED SOCIETIES.

The following societies have indicated their intention to meet in St. Louis, in convocation week, in affiliation with the American Association for the Advancement of Science or with the American Society of Naturalists. For further details, the daily programs should be consulted.

The American Anthropological Association will meet in affiliation with Section H. President, W J McGee; Secretary, George A. Dorsey, Field Columbian Museum, Chicago, Ill.

The American Chemical Society will meet on Monday and Tuesday. Hotel headquarters will be at the Southern. Meetings will be held in affiliation with Section C. The address of the retiring president, Dr. John H. Long, on 'Some Problems in Fermentation,' will be given in Room 102 of the high school, on Wednesday evening, at 7:30. President, John H. Long; Secretary, Wm. A. Noyes, Johns Hopkins University, Baltimore, Md.

The American Mathematical Society—Chicago Section will meet on Thursday and Friday in affiliation with Section A of the Association. Titles and abstracts of papers should be in the hands of the secretary not later than Saturday, December 12. Secretary, Thomas F. Holgate, Northwestern University, Evanston, Ill.

The American Microscopical Society will meet, probably on Tuesday. A stereopticon will be provided for the use of members. President, T. J. Burrill; Secretary, H. B. Ward, Lincoln, Nebraska.

The American Physical Society will meet in affiliation with Section B. President, Arthur G. Webster; Secretary, Ernest Merritt, Cornell University, Ithaca, New York.

The American Psychological Association will meet on Tuesday and Wednesday. President, W. L. Bryan; Secretary, Livingston Farrand, Columbia University, New York, N. Y.

The American Society of Naturalists will meet on Tuesday and Wednesday. The public discussion, on 'What Academic Degrees should be conferred for Scientific Work,' will be held on Wednesday afternoon, and the annual dinner will be given at the Mercantile Club, on Seventh and Locust Streets, Wednesday evening. Members of this and affiliated societies are requested to register and procure tickets for the dinner at the local secretary's office as early as possible in the week. President, William Trelease; Secretary, Ross G. Harrison, Johns Hopkins Medical School, Baltimore, Maryland.

The American Society of Zoologists—Central Branch will meet in affiliation with Section F. President, J. E. Reighard; Secretary, Frank Smith, University of Illinois, Urbana, Ill.

The Association of Economic Entomologists will meet on Tuesday and Wednesday. President, M. V. Slingerland; Secretary, A. F. Burgess, Columbus, Ohio.

The Association of Plant and Animal Breeders will hold its first meeting on Tuesday, Wednesday and Thursday. Chairman, W. M. Hays, St. Anthony Park, Minn.

The Astronomical and Astrophysical Society of America will meet in affiliation with Section A. President, Simon Newcomb; Secretary, George C. Comstock, University of Wisconsin, Madison, Wis.

The Botanical Club of the Association will probably meet as convenient times.

The Botanical Society of America will meet on Tuesday, Wednesday and Thursday. The address of the retiring president, Dr. B. T. Galloway, will be on 'What the Twentieth Century demands of Botany.' President, Charles Reid Barnes;

Secretary, Daniel T. MacDougal, Botanical Garden, Bronx Park, N. Y.

The Central Botanists' Association will meet in affiliation with Section G. President, Conway MacMillan; Secretary, C. F. Millspaugh, Field Columbian Museum, Chicago, Ill.

The Entomological Club of the Association will meet at convenient times. President, E. A. Schwarz; Secretary, C. L. Marlatt, Department of Agriculture, Washington, D. C.

The Fern Chapter will meet at times to be announced. President, B. D. Gilbert; Secretary, H. D. House, Botanical Garden, Bronx Park, New York, N. Y.

The Geological Society of America will meet on Wednesday at its hotel headquarters, at the Southern. Subsequent sessions may be held in room 210 of the high school. President, S. F. Emmons; Secretary, H. L. Fairchild, Rochester, N. Y.

The Sigma Xi Honorary Scientific Society will meet at a time to be announced later. The annual banquet, to be followed by an address by Dr. David Starr Jordan, will be given at the Mercantile Club, Seventh and Locust Streets, on Thursday evening at seven o'clock. Members are requested to register and procure tickets for the banquet, at the desk of the local secretary, as early as possible in the week. President, S. W. Williston; Secretary, E. S. Crawley, University of Pennsylvania, Philadelphia, Pa.

The Society for Horticultural Science will hold its first regular meeting on Monday and Tuesday. President, L. H. Bailey; Secretary, S. A. Beach, Experiment Station, Geneva, N. Y.

The Society for the Promotion of Agricultural Science will hold its quarti-centennial meeting on Monday. President, William Frear; Secretary, F. M. Webster, Urbana, Ill.

All members of affiliated societies who are not members of the American Association for the Advancement of Science are nevertheless requested to register at the desk of the local secretary, so that an approximate record may be made of the total number of scientific men in attendance at the convocation week meetings. Members of the American Society of Naturalists and its affiliated societies, and of the Sigma Xi Honorary Scientific Society are also requested to procure tickets for the annual dinners of these societies from the local secretary as soon as possible after arrival, so that arrangements for the dinners may be perfected.

*THE TYPICAL COLLEGE COURSES DEALING WITH THE PROFESSIONAL AND THEORETICAL PHASES OF ELECTRICAL ENGINEERING.**

At the Chicago meeting of the American Institute of Electrical Engineers held eleven years ago, I presented a paper relating to the subject now under discussion. The proposed subject then apparently created some consternation amongst the members of the committee on papers, who seemed to fear that it was not of sufficient interest to the society. The old prejudice still held against 'college men' in the minds of so-called 'practical men' who had grown influential in engineering practice without having had experience of college life and training. Happily the foundation for this prejudice has ere this been destroyed through the influence of the industrial results achieved by college men. The old prejudice, so far as it now exists, has more particularly drifted into the way of criticism of the engineering schools rather than their graduates, and the character of the schools and the training they afford are

* Paper read at the joint session of the American Institute of Electrical Engineers and the Society for the Promotion of Engineering Education, held at Niagara Falls on July 3, 1903.

subjects of eager discussion in engineering circles.

This extended interest now manifested in the work of the engineering schools produces a situation which may be of great usefulness to the schools. The character of a college may be that which its alumni determine, and any engineering school may be improved by thoughtful suggestions and broadly considered criticisms emanating from its alumni and others who have its best interests at heart.

Two fundamental propositions must be held clearly in view in all such criticisms, if they are to be of service to the educational administration of the engineering colleges:

1. That it is the business of these colleges to train young men into fertile and exact thinkers guided by common sense, who have a profound knowledge of natural laws and the means for utilizing natural forces for the advantage of man. In other words, it is the business of the engineering colleges to produce, not finished engineers, but young men with *a great capacity for becoming engineers,* the goal being obtained by the graduate only after years of development in the school of life.

2. The problem to be met by the engineering colleges is more particularly a problem in *how to properly train* to the stated purpose. The names attached to the subjects taught are not so important as the results produced by the teaching—namely, the effect impressed on the students' powers. This is a teacher's problem—a question of pedagogy, rather than of the engineering profession. It must be met with all the directness and power of the engineer's best efforts, but it can not be solved as solely relating to the engineering profession. Much error on this point lies in the minds of many who assume the part of critics of the curricula of the engineering schools.

In this connection I may be permitted to point out that proposals set up as apparently new in the presidential address one year ago, by President Steinmetz of the American Institute of Electrical Engineers, have for many years been largely included within the ideals of numerous American colleges of engineering. It must be admitted that only a few of the engineering schools are living up to their better ideals. This is partially due, on the one hand, to personal or institutional ambitions which foster the sensational or spectacular and thereby inevitably ruin good teaching, and, on the other hand, to the meager support in both encouragement and funds which I have noticed is the lot of the engineering schools attached to many universities. The latter like the former is often the result of personal prejudices or ambitions.

Most of the faults which are so trenchantly and indiscriminately charged to engineering colleges by many engineers should, so far as they are real, be laid to the pedagogical inexperience and faulty ambitions of the authorities of the many colleges; and exception should be made of the few of the first rank, in which, it is safe to say, the ideals are high and well centered and the administrative organizations hold the ideals continuously in view.

The query here naturally arises: Of what do these ideals properly consist and how fairly should they be met by the college before its course in electrical engineering may be approved as of first rank?

Electrical engineering demands industrial engineers—men with an industrial training of the highest type, competent to conceive, organize and direct extended industrial enterprises of broadly varied character. For the highest success, these men must be keen, straightforward thinkers who see things as they are, and are not to be misled by fancies; they must have an extended, and even profound, knowledge of

natural laws (more particularly of those relating to energy which rest on the law of conservation of energy), an extended knowledge of the useful applications of these laws, and an instinctive capacity for reasoning straight, from cause to effect. Moreover, they must know men and the affairs of men—which is sociology; and they must be acquainted with business methods and the affairs of the business world. Briefly, to reach his highest influence, each man must combine in one a man in the physical sciences, a man in sociology and a man of business. All engineers can not reach this high mark, but the engineering college course should start each of its students toward that degree of attainment which his individual powers will permit.

Michael Faraday (whose conservatism and intellectual clearness are proverbial) said that it requires twenty years to 'make a man' in the physical sciences. The engineering school must put each student in the way of becoming, so far as his mental and physical powers warrant, not only a man in the physical sciences, but a man in sociology and a man in business as well; and this must be done within the narrow limits of four years. It is clear that only the foundations of 'the man' may be laid in the prescribed time, and the engineering college must, therefore, rigorously hold itself to the fundamentals. The engineering college faculty which is contented to deal out so-called 'information courses' on the narrowly empirical side of engineering practice, deals a wrong to its students which they may not recognize at the moment, but which will ultimately tell heavily against their success.

The students that enter the engineering schools of the west, and I presume likewise of the east, are from amongst the most vigorous minds of the high schools and preparatory schools; and yet it must be admitted that they ordinarily possess little power of clear thinking, power of initiative, regard for accuracy, or understanding of continuous and severe intellectual effort, as these important attributes are understood in industrial circles. They are not yet mature in body and are less mature in mind (the latter being, I think, in accord with the natural order of development). But they commonly are well equipped with physical vigor and latent mental strength. Their preparatory schooling has given them a defective acquaintance with the construction of the English language and the spelling of English words, a still more defective acquaintance with French or German or a fairly good grounding in elementary Latin, a smattering of civics and history, a training in the elementary principles of arithmetic, geometry and algebra from which the factor of accuracy in application has often been omitted, and perhaps an enthusiastic interest in the physical sciences.

This enumeration of the attainments of the students entering the engineering colleges may perhaps be interpreted as reflecting on the secondary school teachers, but I wish vigorously to deny the validity of any such interpretation. I can truthfully say that, considering all of the conditions, there is no more painstaking and right-wishing body of people than these teachers.

Many of the faults in the preparatory training of our engineering college students are caused by a doubt which is now apparently agitating educational circles on account of the question whether the high schools shall be the 'people's colleges' or remain in the station of secondary or 'preparatory' schools. This doubt is apparently not yet resolved in the minds of the molders of educational thought; but the traditional old-time secondary school training which produced men who could spell and cipher and who had received a

thorough and accurate drill in the details of one language, is certainly to be preferred as a preparation for an engineering college course. In my own estimation, when accompanied with history and a year spent in civics and natural science, it is not only to be preferred as a school course for preparing the student for college, but also a course for those numerous students who can not go through college.

Taking the students as they come and may be expected to come for the present, the electrical engineering course must include the following branches of learning which are preparatory to the more strictly professional studies:

1. That fuller training in the construction of the English language which is requisite to clear thinking and clear writing, preferably accompanied by an additional language for added strength.

2. The collateral art of expression in drawing.

3. Mathematics through an appropriate amount of calculus, including the integration and solution of equations involving derivatives and instruction in the use of coplanar vectors, and perhaps quaternion quantities, all of which should be taught as applied logic, with special emphasis laid on interpreting the meaning of equations.

4. The science of chemistry, soundly taught.

5. The science of physics, soundly taught, with particular emphasis laid on the elementary mechanics.

6. Applied mechanics.

Mechanics—the philosophy of matter, force and energy—is the backbone of the electrical engineer's college training.

Instruction in the science branches should be accompanied by well-conceived and properly conducted laboratory work, mostly of quantitative character, accompanying and illustrating the class-room instruction; and all instruction whether in natural science, mathematics or languages, should be under the direction of men who are engineers or in full sympathy with the aims and ideals of engineering.

A limited amount of manual training may well accompany these studies, and likewise, if time can be found for it without over-burdening the reasonable physical powers of the student, a limited amount of proper instruction in surveying (including the use of the compass, transit and level) will always prove a force for quickening the student's perceptions and at the same time put him into possession of processes of probable future value.

In a few of our engineering colleges which rigidly demand the best preparatory work from the high schools, and which are, at the same time, best manned in their faculties, not less than two years are required to cover the ground above described, if the work is done in a reasonably satisfactory manner. But the above ground can not be covered with anything like reasonable success in much or any less than three years in the larger number of engineering schools that are usually accorded high rank. After covering these branches, it seems to be the tendency in many colleges to fly off into superficial or descriptive courses, relating to engineering practice, during the remaining time of the allotted four years. This is especially apparent in those colleges where the faculties are ambitious to see their graduates take an *immediate* place of considerable responsibility in the world. This is a fault that destroys much of the ultimate advantage which the students may derive from their engineering course. It is a fault, also, which casts just suspicion on engineering education alike in conservative academic circles and in well-informed industrial circles.

A resort to mainly descriptive courses of instruction during the latter portion of the

students' life in college largely neutralizes the advantage flowing from the instruction in the fundamentals heretofore described. The students are yet to be taught many things relating to engineering life. They must learn something regarding the forms and formalities relating to the affairs of business life. They must learn the characteristics and uses of materials, their correct application to the building of actual structures, the meaning of kinematics and the processes of designing and using real machinery. They must also learn to reason regarding the special principles of hydraulics and thermodynamics, and the way in which they enter into the design, construction and operation of machines, and the manner in which they modify the usefulness of machines and the efficiencies of numerous industrial operations. Again, they must learn to reason clearly and rationally in regard to the specific principles relating to applied electricity, including its widely diverse factors, and the way in which these principles enter into every-day practise. And they should learn something of the history of the development of engineering and of the lives of its great men, for the stirring of proper ambitions.

The electrical engineering department should be divided into not less than four subdivisions, comprising respectively: Applied electromagnetism, which includes the principles relating to electromagnetic machinery and apparatus; the theory and practice of alternating and variable currents, which include the principles relating to all those numerous phenomena which accompany variable current flow; applied electrochemistry and electrometallurgy; and electrical installations, which includes the applications in engineering practice of the numerous principles to the design, construction, operation and testing of complete installations and the component parts thereof.

The teaching force of the department should afford a competent expert engineer for the head of each of these subdivisions, and such additional well-trained force as may be necessary to adequately carry on class-room and laboratory instruction for the particular numbers of undergraduate and advanced students which attend the college. The head of such a department should spend much of his time in supervising the teaching in class-room and laboratory which is performed by his various subordinates.

But through all of this professional instruction of the latter part of the course, it is still *principles, principles, principles,* and rational methods of reasoning which must be taught, if full justice is done the students, until each student becomes a man of open mind, keen observation, analytical thinking and accurate powers of inference. This instruction should be kept close to the tenets of good practise, and the senses of the student should be constantly stimulated by illustrations and problems drawn from practice. The drill in reasoning can undoubtedly be best gained through rational instruction in the useful applications of scientific principles and laws; and no criticism can be justly passed even by the most conservative educational circles because the graduate is enabled to earn his living as a result of this training; but the purely descriptive should ordinarily be avoided except in a few cases where it has a specific function in improving the understanding of an application of principles or is adopted as a desirable auxiliary to stimulate the sustained interest of the students and thus add vitality to the teaching. Indeed, except for the purposes here defined, the introduction of the purely descriptive into the electrical engineering course wastes the students' time and injures their training, thus abridging their prospects of ultimate breadth and power.

The typical courses in electrical engineering which are to-day advertised in college catalogues belong to three classes or combinations thereof. Only the third of these may be acknowledged to fairly meet the proper ideals in such a course. It is to be remembered that I speak of professional engineering. No one possesses a fuller sympathy with the ideals of schools for training men for the mechanical trades short of engineering and bordering thereon, but these schools are not considered in my present discussion.

First, are courses in which predominate the old time instruction in physics with far more to do with the illustration of the beauties of nature than with the great underlying natural laws. The teaching of mathematics, mechanics and like groundwork studies is not ordinarily well supervised in colleges that maintain such courses in electrical engineering, because the administrative authorities are out of touch with the industrial world and mistakenly put the superficial and spectacular in science into the place of that sound instruction only through which an engineering course may be rightly maintained. It is needless to add that the average graduate from courses of this type is ordinarily of less value in engineering than the average graduate from an old-time classical course where at least thoroughness is a requirement; and electrical engineering courses of this type are rapidly disappearing through a merging into one of the following types.

Second, are courses in which the groundwork studies (English, mathematics, chemistry, physics, mechanics) are perhaps reasonably well taught through the earlier years, but in which the latter part of the course is diverted to the training of inexperienced students for immediate 'jobs' where the students may find some responsibility and proportionate pay immediately after graduation. These courses do not teach engineering in the sound sense. They are likely to injure the future of promising students by occupying time in teaching them handicrafts in college which they could better learn in the factory or field, or in teaching empirical methods of practise which change almost before they can be put to useful account by the graduates.

The students in these courses frequently gain the impression that the highest type of engineering practice is no more than an advanced artisanship, and that a graduate from the electrical engineering course is the equivalent of a journeyman. The most serious injury flows from this, through the undesirable narrowing of ideals and ambitions. This unfortunate result occurs the more readily because the popular usage of the word engineer makes it denote either an engine driver (a man of purely manual calling) or a man skilled in the principles and professional practice of engineering.

Third, are courses following the ideals which I have herein earlier described. Incompetent students who enter these courses are soon discouraged and drop out. Those whose calling is to artisanship go elsewhere either to a different school or directly to an apprenticeship. Those who complete the course, as a rule, are competent men; but they are not likely to enter immediately into positions of much responsibility, but rather to go into the so-called 'cadet' positions or 'student' positions of great industrial enterprises, for the purpose of gaining that experience in the crafts which may enable them to make the most extended use of their training in principles. Here they gradually 'find themselves' and ultimately reach the influence in the industrial world for which their caliber and training fit them. These men, if properly taught, have clean-cut ambitions and high ideals as well as the

ability to think well and do wisely. Their earnings and perhaps their usefulness to their employers, may be not so great for a short interval as those of the men who are taught more of empiricism and artisanship and less of rational science during their college courses, but the advantage soon flows in a strong current towards the scientifically trained.

The men who are responsible for this third type of electrical engineering courses may reasonably cry to be delivered from judgment upon the success of their work, which is based on the average earnings of the graduates during their first year out of college. The medical schools and law schools are judged by the attainments of their graduates reached in a decade or even in a quarter of a century, and this also should be the basis upon which to judge the work of the electrical engineering courses of this third and highest type.

Do not believe for a moment, however, that I would teach all theory and no practise. The earlier parts of this paper prove the contrary. In truth, right theory and the best practise are one, and practise which is out of accord with right theory is mere rule of thumb and can be bettered. The best college course in electrical engineering is the one which so teaches the fundamentals that right theory may be fully grasped, and which constantly illustrates the bearing of theory by examples derived from good practise. The administration of such a course requires thoughtful, clear-headed men, who are acquainted with the principles and right practise of pedagogy as well as trained in the principles and experienced in the practise of engineering.

My discussion of the subject makes it clear that there is a wide variance between the methods of the colleges which support electrical engineering courses. Complete unity is not only impossible but would undoubtedly be undesirable, since scope for individuality is as essential here as in the control of industrial enterprises; but the cause of sound college training for electrical engineers would be advanced by any action which clearly places the true aims of the college courses in electrical engineering before the authorities of all of our colleges which support such courses. And I may add that many of the greatest weaknesses of electrical engineering courses are due to the fact that the executive heads of the colleges or universities do not always understand what engineering truly stands for, and they equally often have no fair conception of the soundness of training that is required for its practise.

Dugald C. Jackson.
University of Wisconsin.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—SECTION OF ANTHROPOLOGY.

The seventy-third annual meeting of the British Association was held in Southport, Lancashire, September 9–16. As will be seen by the dates, the meeting lasts a whole week, from Wednesday to Wednesday. Professor Johnson Symington, of Queen's College, Belfast, presided over the anthropological section. His address, published in a recent issue of this journal, was a plea for a more thorough and systematic collecting of human brains for purposes of detailed and comparative study; also a more thorough study of the cranial cavity in relation to the outer surface of the skull, on the one hand, and, on the other, its relation to the brain itself. It is known that definite areas of the cerebral cortex are connected with the action of certain groups of muscles; and that the nervous impulses, starting from the organs of sight, hearing, smell and touch, reach defined cortical fields. But all these do not cover

more than a third of the convoluted surface of the brain. The problem before anthropologists is to explore the remaining two thirds of the brain surface, which is still practically a *terra incognita*.

A number of papers on somatology followed Professor Symington's address. A collection of some eighty skulls from Round Barrows in East Yorkshire was the subject chosen by Mr. William Wright, of the University of Birmingham. The interments closely resemble each other, and belong to the late Neolithic and early Bronze Age. A great variety of cranial shapes are met with, the cephalic index ranging from 69 to 92. Metopism, when found, occurred in long skulls rather than broad skulls. There seemed to be no correlation between skull-shape and the mandibular and coronoid indices. Dr. Thurnam's dictum 'round barrow, round skull' is not even approximately accurate for the round barrows of Yorkshire.

Mr. Annandale's paper on a 'Collection of Skulls from the Malay Peninsula' dealt with material which he himself had helped to collect. The crania in question came from the Patani states, the population of which is very mixed, consisting partly of so-called Malays and partly of so-called Siamese, the difference between the two peoples being chiefly one of religion. The series has a higher cephalic index and a greater cubic capacity than would be found among the jungle tribes of the Malay Peninsula. Another distinguishing feature is the tendency of the third molar to disappear.

Mr. E. J. Evatt, in his paper entitled 'Some Observations on the Pads and Papillary Ridges on the Palm of the Hand,' pointed out that during the course of development of the hand eleven well-defined pads or cushions appear on the palm. The disposition and form of the pads when best marked in the fœtus correspond very closely with that which obtains in certain animals, *e. g.*, the mouse; the cushions in both cases are probably morphologically equivalent, and in man's remote ancestors possibly served similar functions. The pads in the adult may be regarded as vestigial. The papillary ridges were differentiated when the hand began to be used as an organ of prehension rather than locomotion, and the patterns assumed their present form as the result of mechanical forces.

Mr. David MacRitchie in 'Mongoloid Europeans,' supports Beddoe's view to the effect that 'some reason can be shown for suspecting the existence of traces of some Mongoloid race in the modern population of Wales and the West of England.' This strain may have come direct from the cave man or from a fresh Mongoloid immigration at a much later date, *e. g.*, the Hun conquests of the fifth century.

The committee appointed by the British Association to organize anthropometric investigation in Great Britain and Ireland submitted an important report, and asked to be reappointed with instructions to carry out the recommendations of its chairman, Professor J. Cleland, and to draft a scheme for a central anthropometric laboratory. Such a laboratory would 'collect and disseminate information on anthropometric work, give practical instruction in measurements, and supply schedules.'

By this means, uniform standards in anthropometric investigations would be secured, measurements best suited for any specific problem could be recommended, and cooperation among investigators assured. It is suggested that the central laboratory be attached to some already existing institution, preferably the Anthropological Institute.

The committee on 'Anthropometric Investigations Among the Native Troops of the Egyptian Army' (Professor A. Mac-

alister, chairman) announced that since their last report, Dr. C. S. Myers has published a paper in the current number of the *Journal of the Anthropological Institute* on 'Tattooing in Modern Egypt,' the material for which was procured in the course of the committee's investigations. Dr. Myers has also presented an album to the Anthropological Photographs Committee of the British Association which contains some four hundred photographs, full face and profile, of Egyptians and Sudanese. The committee asked for a grant of £35 to defray the services of a clerk, who, under Dr. Myers's supervision, will tabulate, average and determine the variability and correlation of the various series of measurements already collected.

The Scottish Ethnographic Committee (Mr. E. W. Brabrook, chairman) reported a delay in the 'Pigmentation Survey of the School Children of Scotland,' owing to the difficulty of procuring suitable lithographic color cards to be used as color scales for hair and eyes. The Educational Institute of Scotland has passed a resolution recommending the teachers to supply the information desired by the committee, an action which will be of immense value in expediting the survey. The subdivision of Scotland into 110 numbered districts has already been completed.

Papers relating to various fields of archeological research were read. Mrs. Stopes presented two papers, accompanied by exhibits of specimens, and relating to the last discoveries of her late husband. Of 'Paleolithic Implements from the Shelly Gravel Pit at Swanscombe, Kent,' she exhibited the large and small hache types, broad leaf-shaped type, discs, ovate types, awls, boat-shaped type, angular projectiles, graving tools, scrapers and spoke shaves, representing various shades of flint and patina-white, cream, ocherous, brown, black. Many of them are derived and water worn. The implements were found associated with a fauna containing many extinct species.

The 'Saw-edged Paleoliths' presented by Mrs. Stopes were from the Craylands gravel pit at Swanscombe. The serration is intentional and not a result of accident or use; is generally on a straight edge, though sometimes continued into spoke shaves and scrapers.

Mr. Llewellen Treacher's paper 'On the Occurrence of Stone Implements in the Thames Valley between Reading and Maidenhead' was read by Mr. Monckton, of the Geological Section. Mr. Treacher's investigations extend to the upper, middle and lower terraces, from all three of which important collections have been made.

Some of the megalithic monuments of Kent were discussed in Mr. George Clinch's communication entitled 'Coldrum, and its Relation to Stonehenge.' Mr. Clinch pointed out that the hitherto published descriptions of Coldrum do not mention its most important and characteristic feature, namely, that between the two upright stones which form the sides of the chamber there stand two stones about midway, forming a partition which divides the space into two sepulchral chambers. The two upright stones are of remarkable size. Their regular form, good proportions and flat surfaces are also noticeable features, suggesting artificial shaping and perhaps dressing. These point to a late epoch of the neolithic period, and present remarkable similarities to the forms at Stonehenge. The idea of enclosing the principal structure within a line of stones is also common to Stonehenge and Coldrum. But Coldrum was obviously a sepulchral monument. Stonehenge, on the other hand, though following to some extent the same arrangement, 'was conceived on a more ambitious scale, and probably designed for a very different purpose.'

The megalithic structures of Kent, in-

cluding Countless Stones, Kits Coty House, several ruined examples in Addington Park and Coldrum itself, furnish a valuable series illustrative of the constructive skill of neolithic man.* Here, as well as at Stonehenge, Sarsen stones were employed. In this connection may be mentioned Mr. H. Balfour's presentation of 'A Model of the Arbor Low Stone Circle.'

Cretan and Egyptian archeology were especially well represented; the former by Messrs. Arthur Evans, J. L. Myres and R. C. Bosanquet, including Dr. W. L. H. Duckworth's report on the prehistoric human remains of Crete (being part of his 'Report on Anthropological Work in Athens and in Crete'); the latter by Messrs. Flinders Petrie, Garstang and C. S. Myers.

Mr. Evans had thought to complete his excavations at Knossos this year. 'But the excavations took a wholly unlooked for development, productive of results of first-rate importance' both as regards architecture and general archeology, and calling for 'supplementary researches of considerable and, indeed, at present, incalculable, extent.'

Mr. John L. Myres's paper: 'On a pre-Mycenæan Sanctuary with Votive Terra Cottas at Palæokastro, in Eastern Crete,' was based on his excavations of April, 1903. The terra cottas were found in a layer of blackened ashy earth, the latter covered by a layer of disturbed soil and of rubble building of early Mycenæan date. The figurines are of 'men and women in characteristic pre-Mycenæan costume analogous to that shown by the frescoes at Knossos, and completed, in the case of the women, by gigantic and very stylish hats; a quite new feature.' There were other figurines representing oxen, rams, goats, pigs, dogs, weasels, hedgehogs, birds, chairs, vases and other objects of daily use.

'Exploration in the East of Crete' and 'An Early Purple-fishery,' both by Mr. R. C. Bosanquet, Director of the British School at Athens, completed the list of papers on Cretan archeology. Leuke, a small island off the southeast coast of Crete, was an important fishing-station in antiquity. An inscription of about 350 B.C. mentions the levying of tithes on the catch of fish and of purple-shell. Messrs. Bosanquet and C. T. Currelly explored the island last May. They found, among the sand-hills on the north shore, a bank of shells, 'some whole, but mostly crushed, of the variety *Murex trunculus,* which is known to have been used in the manufacture of the purple dye.' Fragments of pottery and of a stratile bowl which marked it as not only pre-Hellenic, but pre-Phœnician, were scattered through the heap. Further digging only a few yards away uncovered characteristic Cretan vases of the Kamáres type and the foundations of a house. Enough evidence was obtained to show that the "extraction of the purple juice was practiced in Crete at least as early as 1600 B.C. The Minoans of Crete, and not the Phœnicians, were the probable discoverers of 'Tyrian purple.' "

'The Temples of Abydos' and 'The Beginning of the Egyptian Kingdom' were the subjects chosen by Professor W. M. Flinders Petrie, and made doubly interesting by a long series of lantern views. 'Recent Discoveries, Illustrating some Burial Customs of the Egyptians,' by Mr. John Garstang, and 'Antiquities near Kharga in the Great Oasis,' by Dr. C. S. Myers, were also fully illustrated.

Romano-British archeology came in for a share of attention. Mr. T. Ashby, Jr., reported on 'Excavations at Caerwent,

* The writer took photographs of this series just before the Southport meeting. Unfortunately, the films were all destroyed in transit (post), through being opened, presumably by U. S. customs officials.

Monmouthshire.' This is the site of the ancient Venta Silurum. The external walls of the city are still clearly traceable, forming a rectangle of about 500 by 400 yards, and, on the south side, preserved to a height of some 20 feet. The buildings thus far brought to light consist chiefly of private houses, and some of these present a ground plan which appears to be unique in England, having the rooms arranged round all four sides of a rectangular courtyard.

The Roman sites described by Mr. Garstang, at Brough and Ribchester respectively, were of a different character, both being fortifications. That at Brough in Derbyshire belongs to the earlier class, and was built probably under Hadrian or Antoninus Pius. The Roman fortress Bremettenacum, at Ribchester, has been known since archeological records began to be kept in Britain. Recent excavations show that this station conformed with the general scheme of frontier defenses of the Roman Empire. It was one of the series of fortresses 'which, with the wall of Hadrian, formed the northern frontier defenses of Roman Britain.' On Saturday, set apart by the British Association as excursion day, Mr. Garstang conducted a party of ninety-five to Ribchester.

The two papers on American archeology were 'A West Indian Aboriginal Wooden Image,' by Dr. J. E. Duerden, and 'The Ancient Monuments of Northern Honduras, and the Adjacent Parts of Yucatan and Guatemala, with some Account of the Former Civilization of these Regions and the Characteristics of the Races now Inhabiting Them,' by Dr. T. W. Gann. Miss A. A. Bulley presented 'Some Points about Crosses, chiefly Celtic,' and Mr. Annandale discussed 'The Survival of Primitive Implements in the Faröes and Iceland.'

Personal ornaments among civilized peoples consist of precious metals and stones or imitations of stones, pearls or shells themselves, amber, jet and occasionally various other objects. It has been supposed, hitherto, that purely esthetic considerations led to the use of such objects for purposes of adornment. Professor W. Ridgeway, in 'The Origin of Jewelry,' endeavored to prove that such was not the case. He attributes their use to magic.

Small stones of peculiar form, color or properties were considered magical long before they were worn as ornaments. In Australia and New Guinea, crystals are used for rain-making, although the natives can not perforate them for use as ornaments. In Uganda these same rock crystals are fastened into leather and carried as amulets. In Africa, the sorcerer carries a small bag of pebbles as an essential part of his equipment. Modern cylindrical glass beads are descended from the beryl and quartz crystal. Babylonian cylinders, Egyptian scarabs and Mycenæan gems were not, as has been generally supposed, primarily signets, but amulets. "The Orphic Lithica gives a clear account of the special virtue of each stone, and it is plain that they acted chiefly by sympathetic magic; *e. g.*, green jasper and tree agates make the vegetation grow, etc. Mithridates had a whole cabinet of gems as antidotes to poison. To enhance the natural power of the stone, a device was cut on it, *e. g.*, the Abraxas cut on a green jasper, the special amulet of the Gnostics. The use of the stone for sealing was simply secondary, and may have arisen first for sacred purposes." Cowrie shells are worn as amulets by the modern savages in Africa; similar shells were worn in Strabo's time to keep off the evil eye. Red coral was a potent amulet to the seafarer, as it is at the present day in Mediterranean lands. If powdered, it kept red rust from grain. Pearls are still a potent medicine in China. Seeds of plants have magic properties, the

banana seed being especially valued in Uganda. Claws of lions are such important amulets in Africa that they are quite generally counterfeited. So with the teeth of jackals, which are imitated in wood, if the real thing is not to be had. When gold first became known, it was regarded exactly as the stones mentioned above. "Thus the Debae, an Arab tribe who did not work gold but had an abundance in their land, used only the nuggets, stringing them for necklaces alternately with perforated stones." Magnetic iron and hematite were particularly prized, the belief being that the former was endowed with a living spirit. "It is thus clear that the use of all objects still employed in modern jewelry has arisen primarily from the magical powers attributed to them, by which they were thought to protect the wearer."

Mr. Edward Lovett, in "Some Suggestions as to the Origin of the Brooch, and the Probable Use of Certain Rings at present called 'Armlets,' " suggests, as the prototype of the ring-and-pin contrivance for fastening a cloak, the use, by a hunting people, of the mammalian *os innominatum* and *os calcis*, the corners of the cloak being drawn through the oval perforation of the former, and pierced by the sharp point of the latter. It is further noted that very many rings of early date and of various materials, usually described as 'armlets,' are of too small diameter to allow the entrance even of an infant's hand. "As such rings are frequently found associated with pins of similar materials, commonly regarded as 'hair-pins,' and as ring and pin are sometimes found *in situ* on the breast of a skeleton, it is inferred that they represent a simple ring-and-pin fastening." It was pointed out that an apron fastener of this type, composed of an iron ring and a horseshoe nail, is still worn in some blacksmith shops of Scotland. The shepherds of Perthshire wear a brooch of similar pattern. The next step in the development is to be found in the ring-and-pin fastening so common at present in China. The ring is of agate, and the pin, which is of silver and perforated, is attached to it by means of a silken thread. A further step is taken when the pin itself is hinged upon the ring for security, by bending its flattened head around the ring, a form abundant in Celtic times.

There were a number of communications of general ethnological interest. Dr. W. H. Rivers presented two: 'The Toda Dairy' and 'Toda Kinship and Marriage.' From the ordinary operations of the dairy, the Todas of the Nilgiri hills have evolved an elaborate religious ritual. The priest is the dairy man; the temple, the dairy. The dairy temples are of different degrees of sanctity corresponding to the different degrees of sanctity of the buffaloes tended in each. Only the milk of the sacred buffaloes is churned in the dairy temple. The milk of those that are not sacred is churned in the front part of the huts in which the people live. "The more sacred the dairy, the more elaborate its ritual. The dairy vessels, in all, are divided into two groups, those which come in contact with the milk are the more sacred; those which receive the products of the churning, the less sacred. The kinship system and marriage institutions of the Todas were studied by means of the genealogical method." The system of kinship is 'classificatory,' every male of an individual's clan being his grandfather, father, brother, son or grandson, and every female his grandmother, mother, sister, daughter or granddaughter. As to marriage regulations, the people are divided into two endogamous groups, each of which is subdivided into a number of exogamous groups. There can be no marriage between the two chief groups; a man

must marry a woman of his own division but not of his own clan. The orthodox marriage is that of cousins. The institution of polyandry still exists. When a girl marries a boy it is usually understood that she becomes also the wife of his brothers. "For all social and legal purposes, the father of a child is the man who performs a certain ceremony about the seventh month of pregnancy, in which an imitation bow and arrow is given to the woman." "Fatherhood is determined so absolutely by this ceremony that a man who has been dead for several years is regarded as the father of any children borne by his widow, if no other man has given the bow and arrow." The author considers it possible that the Todas are moving from polyandry toward monogamy through an intermediate stage of combined polyandry and polygeny.

In 'The Ethnology of Early Italy and its Linguistic Relations to that of Britain,' Professor R. S. Conway discussed the various suffixes used by the various tribes to form names of communities derived from names of places. There are only six or seven suffixes used for this purpose in ancient Italy and, of these, only three are significant for ethnology, viz., -co, -no and -ti (generally -ati).

The remaining paper, 'The Progress of Islam in India,' by Mr. William Crooke, admitted the increase of Islam and endeavored to ascertain the cause or causes of it. One of these is physical, tending to make the Mohammedans more fertile and more long-lived than the Hindus. The former are recruited from a more vigorous race, discourage infant marriage and the celibacy of widows, and permit a more varied and invigorating diet.

In addition to the above program, a member of Section H, Dr. Robert Munro, was invited to deliver one of the evening lectures arranged for by the association. Dr. Munro's subject was 'Man as Artist and Sportsman in the Paleolithic Period.'

Mention should also be made of a number not on the published program, a special treat provided for the anthropologists by Mr. James Hesketh, of Southport. The city is built upon blown sand. Some years ago, while engaged in street or sewerage construction, workmen came upon a rather large wooden structure buried some ten or twelve feet beneath the surface of the ground. Mr. Hesketh, on whose property the find occurred, had extensive excavations made prior to the meeting, in order that visiting scientists might see to best advantage what proved to be a pile dwelling or perhaps a landing for boats. A large fragment of a willow mat or basket was found by the piles. It resembles the bird-cage weave of the Clallam Indians. The site is now between one and two miles from the sea.

George Grant MacCurdy.

Yale University Museum.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON.

The 376th meeting was held on Saturday, November 14.

W. H. Dall called attention to the doubt expressed by Dr. True, in a recent number of the *Proceedings* of the Biological Society, as to the existence of dorsal and ventral keels on the posterior part of the body of *Phocæna dalli*. Without offering any comments as to the presence or absence of this character in other porpoises, Mr. Dall showed by the original notes and drawings made at the time of the capture of the type of *Phocæna dalli* that such keels were certainly present in this species.

Lester F. Ward noted a curious case of scientific prediction in which ten species were named and described before they were discovered. This was done by Ehrenberg, who in working on the diatoms, classed by him as infusoria, described a number of species of *Actinocyclus* based on the number of rays. For most of these he had specimens, but for

the species with 27, 29, 30, 31, 37, 39, 41, 42, 44, 45, 46, 48 and 49 rays no specimens had at the time been discovered. Ten of these were found in 1843 and 1844, but the last four seem never to have come to light.

G. K. Gilbert spoke of the twisting of the pines, *Pinus balfouriana*, observed by him in the Kern River region. In many trees the wood had a distinct spiral twist, usually to the right, and the branches twisted in the same direction; in the exceptional cases where the twist was to the left, the branches, as a rule, also followed this direction.

Lester F. Ward presented a paper on 'The Dresden Cycad' (*Cycadeoidea Reichenbachiana*), giving a brief historical account of the cycad trunk from the salt region of Galicia that has been in the Dresden Museum since its discovery in 1753. Its true character as a cycad was made known by Göppert in 1844, when he named it *Raumeria Reichenbachiana*, and he described and figured the specimen in 1853. More recently it had been photographed by Geinitz and a copy of the photograph sent to the speaker, who surmised that the cycad had been mounted in an inverted position, and so stated in his 'Flora of the Black Hills.' In August, 1903, Mr. Ward visited Dresden and had an opportunity to examine the specimen carefully, finding that it was really inverted. The speaker gave as minute a description of the trunk as was possible without cutting sections to show the internal structure, stating that it shows a number of reproductive organs that promise good results when they shall be cut through and examined microscopically.

Under the title 'The Making of a Whale' F. A. Lucas described the making of the mold of an adult sulphur-bottom whale and the preparation of its skeleton, illustrating his remarks by slides from photographs by Mr. William Palmer. He said that in May Mr. Palmer, Mr. Scollick and himself had been sent to a whaling station on the southern coast of Newfoundland, and told how the whales were captured there and made into oil and fertilizer. The method of making the mold, he stated, had been devised by Mr. Palmer, who was at present engaged on the reproduction of the animal for the St. Louis Exposition.

F. A. LUCAS.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 571st meeting was held October 10, 1903. The first regular paper was by Mr. G. W. Littlehales, of the Hydrographic Office, on 'The Locus of Geographical Position and the Compass Error,' depending on the use of special large-scale diagrams and avoiding calculation.

This communication points out a short and simple simultaneous solution, by inspection, of the altitude and azimuth of a celestial body due to an estimated geographical position of the observer.

The results, which are applied directly to the problem of laying down the Sumner line of position and finding the total error of the compass, are obtained with a degree of precision which is well within the margin of error that is inseparable from observations made at sea.

A navigator having measured the true altitude of a celestial body and then deduced the altitude and azimuth of the observed body due to the estimated geographical position of the ship, can draw a line upon his chart through the estimated geographical position of the ship at right angles to the azimuth or true bearing of the observed celestial body, which might be appropriately called the Sumner line of position by account; and next comparing the instrumentally measured true altitude with the altitude due to the geographical position, he can at once draw the actual Sumner line of position, since it will be sensibly parallel to the line of position by account and removed from it by a perpendicular distance equal to the difference in minutes of arc between the observed and deduced altitudes and toward the direction of the observed celestial body or away from it, according as the true altitude obtained by observation is greater or less than the altitude deduced by dependence on the estimated geographical position.

If the compass bearing of the observed celestial body be noted at the time the observation for altitude is taken, the difference

between this bearing and the true azimuth of the body, which is deduced simultaneously with its altitude, will give at once the total error of the compass for the course upon which the ship heads at the time when the observation is made.

Mr. J. F. Hayford reported on 'The Longitude of Honolulu; Various Determinations from 1555 to 1903.' The final telegraphic result is $10^h\ 31^m\ 27^s.24\ .06$. The errors $\pm$ of the many older determinations were pointed out and discussed.

President Gore then read a paper on 'The Political Parties and Policies of Germany'—a study during the past summer at the time of the elections. He pointed out the constitutional relations between the government and the Reichstag and gave an account of the four political groups—Conservatives, Liberals, Particularists and Social Democrats—with their seventeen subdivisions, and the principal features of their platforms. Major Dutton in discussing the paper compared the parliamentary bodies of various lands.

The 572d meeting was held October 24, 1903. Professor Simon Newcomb spoke on 'The Coming International Congress of Science and Art at St. Louis, September 19 to 25, 1904.' He referred to the dissatisfaction that had followed most former congresses and the desire to provide something different for St. Louis. Two features of the plan decided on are noteworthy: (1) The unity of science is to be emphasized by a single congress, though meeting in as many sections as may be necessary. (2) The principal speakers are to be invited to present papers on specific assigned subjects. This rendered necessary a grouping in advance of the subjects that might properly come before the congress. The practical grouping adopted by the administrative committee, consisting of Professors Newcomb, Münsterberg and Small, was published in the May *Atlantic*.

During the past summer that committee has been visiting the learned men of Europe to secure participants in this congress; a considerable number of prominent scholars has been secured, each representing his special field.

President Gore, in the following discussion, pointed out that a congress was a proper adjunct to an exposition, for it represented the theoretical side of those activities whose practical side was represented by the exhibits.

Professor F. W. Clarke then spoke on 'The Dalton Centenary at Manchester' in commemoration of the announcement of the atomic theory, October 21, 1803. The speaker had delivered the memorial address, and here summarized it, pointing out the significance of Dalton's discovery. (The address was published in Science, October 23.) Sundry incidents of the festival were spoken of, and the fact noted that the statues in the fine town hall were not those of soldiers, but of scientific men—Dalton and Joule.

Professor Clarke added some account of the International Congress of Applied Chemistry at Berlin, and of his visits to various fine new laboratories; though he found none finer than some in this country.

President Gore told of his attendance at a meeting of the Berlin Academy of Sciences when memorial addresses were made on Virchow, and of the curious coincidence that he had also been present when Du Bois Reymond introduced the newly elected Virchow to the society.

Charles K. Wead,
Secretary.

NEW YORK ACADEMY OF SCIENCE,
SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

The regular meeting of the section was held October 20, in New Haven, Conn., in conjunction with the New York Branch of the American Psychological Association and the Philosophical Club of Yale University. The following papers were presented:

Localization of Brain Function: Dr. S. I. Franz, of Dartmouth Medical College.

Dr. Franz presented an account of an attempt to determine by physiological experiments whether or not the so-called motor areas are also sensory in function. Cats were used in the investigation, and the results indicate that in these animals the motor cortex has also certain sensory functions. It was not determined with what sensory processes

the areas are concerned, but results of clinical observations made it appear probable that the center for muscle sense is there localized.

The Application of the Concept of Variability in Reaction-Time Work: Dr. ROBERT YERKES, Harvard University.

Inasmuch as the degree of constancy of reaction-times differs for different species, individuals, conditions of the individual, modes and intensities of stimulation, it is clear that variability is an important quantity in the analysis of reactions, which should make possible the quantitative estimation of the influence of the various factors which play a part in determining the time of reaction.

The mean or average variability is generally determined in recent studies of reaction-time, but of far more importance for comparative work is what may be known as the relative variability. This quantity is an index of variability, which gives not the absolute variableness of the reaction-time, but the ratio of the variability to the time of reaction. For reaction-times, which are symmetrically distributed about a mode, the relative variability may be gotten from the formula

$$\frac{\text{mean variability} \times 100}{\text{mean}}.$$

In case of asymmetrical distribution Pearson's formula for obtaining the coefficient of variability should be used.

Examination of reaction-time statistics in which the variability is given indicates that the relative variability, as well as the time of reaction and the mean variability, decreases with increase in the strength of the stimulus. For electric stimulation this appears to be true from the threshold intensity to that which causes a reflex reaction, but in case of other modes of stimulation it is possible that beyond a certain point increase in intensity of the stimulus causes slower and more variable reactions.

Since the time of reaction varies with the intensity of the stimulus it is useless to compare reaction-times for different modes of stimulation, or those of different species or individuals, unless the relative variability is known. It is not improbable that careful investigation of the relation of relative variability to reaction-time will furnish a satisfactory basis for the accurate comparison of different results. To say that one person reacts more quickly than another to a given stimulus without taking into account the variability of the reaction-time is meaningless.

The 'Specious Present' and the Real Present: Dr. W. P. MONTAGUE, Columbia University.

A psychosis, like all systems, possesses in its totality a form or structure which is distinguishable, as the perceiving subject, from its individual contents, as perceived objects. Changes in the individual contents produce concomitant, though generally lesser, changes in the totality. The segment of duration or change perceived at any one moment is not itself a real change, but simply the *ratio of the change-rate of the individual contents to the change-rate of the totality, at that moment;* and this ratio, though finite and variable, does not itself require a finite time for its realization. Each unextended moment of 'real' time is thus adequate for the appreciation of an extended period of perceptual or 'specious' time.

The Effects of Practice on the Poggendorff Illusion: Mr. E. H. CAMERON and Mr. W. M. STEELE, Yale University.

This paper reported the results of a series of experiments dealing with the effect of practice on the Poggendorff illusion. (1) Quantitative determinations were made with a number of illusions; (2) practice with one illusion was carried on for an extended period; (3) determinations were again made with all of the illusions which were used before the practice series.

The apparatus used was demonstrated. The results show that the illusion tends to disappear after a period of seven weeks' practice. The effects of such practice were found to hold good for figures other than that with which the practice was made.

The Zöllner Figure: DR. CHARLES H. JUDD, Yale University.

This paper reported a series of quantitative determinations of the amount of illusion in the Zöllner figure when the figure was rotated

through 360 degrees and was divided so that the illusion for each of the long lines was determined without reference to the next long line. It was found that the illusion is not the result of equal deflections in opposite directions of the neighboring lines. In some cases one of two neighboring lines is not deflected at all, or even in a direction opposite to that usually assumed. The important deflection is in every second long line. Rotation through various angles shows that there are four positions in which deflection is great, four in which it is small.

Statistics of American Psychologists: Professor J. McKeen Cattell, Columbia University.

Professor Cattell described the methods he has employed to select 1,000 American men of science for scientific study. Among about 4,000 scientific men, there are about 200 psychologists. The methods by which they were arranged in the order of merit were explained, and the possibility of measuring degrees of scientific merit by the positions and probable errors was discussed. Some statistics were then given in regard to the academic origin, course and distribution of the psychologists. They were educated at 76 different colleges, this large dispersal indicating that in general psychologists are not greatly influenced by the institutions at which they study. The numbers who pursued graduate studies at different institutions were: Berlin 35, Leipzig 35, Columbia 31, Clark 31, Harvard 30, Cornell 25, Yale 16, Johns Hopkins 13. Of the 200 psychologists, all but eight are engaged in teaching or administrative educational work, being distributed among 77 institutions. Statistics were also given in regard to publications, from which it appears that the United States contributes about one seventh of the more important publications, leading in experimental psychology. The paper will be published in the *American Journal of Psychology.*

The Participation of the Eye Movements in the Visual Perception of Motion: Professor Raymond Dodge, Wesleyan University.

Photographic registration of the eye movements has exposed the poverty and inaccuracy of all introspective data with respect to their number, velocity and amplitude. While it shows that, even if our consciousness were full and exact in all three respects, it would be either useless or misleading as a datum in the visual perception of motion.

Every pursuit movement of the eyes is a definite muscular reaction to retinal stimulation. As such it is evidently conditioned both in direction and in velocity by some definite characteristics of the stimulus which occasions it. Since its accuracy can never transcend the accuracy of the data on which it occurs, it follows that the kinesthetic factor from a reactive pursuit movement could never correct nor materially augment the data furnished by the stimulus.

Moreover, the reaction of the eye involves a long reaction interval, about 160–170 σ. This suggests both the relative unimportance of the actual motor response and a considerable elaboration of the sensory data in what seems like a simple reaction. But any reaction interval at all renders it impossible for the actual eye movement to parallel the movement of the object of interest either in velocity or in amplitude.

Experimental verification of the above takes two forms: Whenever all other sensory data for the perception of motion are suppressed, except the hypothetical kinesthetic factor, there is no immediate perception of motion. And whenever the former are distorted by eye movements, the appearance of motion is respectively decreased or increased, entirely without correction by kinesthetic data.

On the Horopter: Dr. Geo. T. Stevens, New York City.

A horopter will be formed when the two eyes are so adjusted as to enable the image of the point fixed to be located exactly at the maculas of the two retinas. It follows that horopters succeed each other in endless variety and with amazing rapidity. With every glance a new horopter is developed. Two tenets constitute the essential foundation for the doctrine of the horopter the theory of actually horizontal and actually vertical meridians of the retinas and a doctrine of corresponding points.

Corresponding points of the two retinas are those which answer to proportional degrees of rotation of the eyes about the center of rotation, and which, from given individual points in the plane of fixation, each receive incident rays which must pass through the nodal points. They represent, therefore, the relation between the muscular and the retinal senses.

Intelligence and Movement: Dr. R. S. WOODWORTH, Columbia University.

In discussing the relations of 'Intelligence and Movement,' Dr. Woodworth argued that the mental cue of a voluntary movement was not ordinarily a kinesthetic image of the movement. Even in learning a new movement, experiment shows that no such image need be present. Since voluntary movement is developed from instinctive, the original mental cue must have been that provided by instinct, and the instinctive cue is never an image of the movement about to be made. The actual sensation of a movement can evidently not be the stimulus to that same movement, and the reproduced sensation can hardly have a motor power not possessed by the sensation itself.

The Minimal Value of the Psychophysical Reaction-Time: Professor LIGHTNER WITMER, University of Pennsylvania. Read by title.

Primary and Secondary Presentations: Mr. H. R. MARSHALL, New York City. Read by title.

JAMES E. LOUGH,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

AT the meeting of the section on November 2, Dr. Bergen Davis read a paper on 'The Electrical Conductivity and Absorption of Energy in the Electrodeless Discharge.'

The discharge was produced in a globular vessel by the high frequency discharge from a Leyden jar system. The vessel in which the discharge was produced contained electrodes which were connected through a galvanometer to a source of E.M.F. of 220 volts. When the discharge passed in the vessel, the gas became a good conductor. The conductivity as indicated by the galvanometer was found to depend on the pressure of the gas somewhat. That is, when the pressure becomes so low that the white discharge appeared, the conductivity increased to near a maximum. It remained nearly constant until at a low pressure the discharge disappeared, when the conductivity became zero.

The absorption of energy was measured by placing a hot-wire galvanometer in the circuit leading from the jars to the coil surrounding the vessel. The oscillating current passing through this galvanometer and coil can be expressed by

$$c\,Ae^{-qt} = \cos pt.$$

The greater part of the energy is dissipated in heating the gas and the vessel. The energy will be proportional to the square of the current, while the galvanometer reads current direct. Hence

$$\text{Reading} \propto \int_0^\infty e^{-2qt} \cos pt\,dt,$$

$$\text{Readings} \propto \frac{2p^2+3q^2}{4q(p^2+q^2)},$$

$$\text{Readings} \propto \frac{1}{q}.$$

That is: a certain reading is obtained without the vessel in the coil. When the discharge passes in the vessel, the readings drop back to a smaller value. This drop-back is proportional to the dissipation q in the circuit. The energy absorbed reaches a maximum near the pressure at which the discharge first appears. It steadily decreases and becomes zero again at the pressure at which the discharge disappears.

A second paper was read by Dr. Charles Lane Poor, on 'The Measurement of Racing Yachts.'

The measurements discussed in this paper are made for the purpose of classifying the yachts and furnish a basis for handicapping them in racing. From such measurements, made of the hull, spars and sails, an expression is found for the 'theoretical speed,' or speed the yacht should make under normal conditions. While every little detail of hull and rigging contributes its part in producing a fast yacht, yet it is manifestly impossible to take account of all such details in finding the

'theoretical speed'; only the main factors can be considered. These factors, which enter the rules in common use, are length of hull, sail area and displacement.

It was shown that the rules introduce these factors in such a way as to involve the assumptions that speed is proportional to: (*a*) The square root of length; (*b*) the fourth root of sail area; and that the New York Yacht Club rule involves these two assumptions and the additional one that speed is proportional to (*c*) the inverse sixth root of displacement.

Dr. Poor discussed these assumptions in detail and showed that, while there is some apparent basis for the assumption in regard to length, there appears to be no scientific basis for those in regard to sail area and displacement. In fact, the available data seem to point to the conclusion that the assumption in regard to sail area is wrong, that speed is more nearly proportional to square root of sail area. In support of this view the results of many races between two yachts in 1902 and 1903 were used. Dr. Poor called attention to the scientific aspect of the problem, and suggested several lines of experiment, by means of which the relationship between speed and the factors of measurement could be determined.

S. A. Mitchell,
Secretary.

CLEMSON COLLEGE SCIENCE CLUB.

At the meeting of October 17 Dr. R. N. Brackett discussed 'An Improved Welsbach Mantle.' A brief historic review of Welsbach's work in originating and perfecting the mantle which bears his name was given. The experiments in varying the proportions of the rare earths and observing the effects produced were mentioned. As a result of these experiments, the best results seem to be obtained with a mixture of the rare earths in the proportion of approximately 99 parts of thoria to 1 part of ceria. The explanations which have been offered for the phenomena observed in the use of the mantle were mentioned. The recent improvements by which the mantles have been hardened and thus adapted to use in railway trains, etc., were pointed out.

Professor Chas. E. Chambliss read a paper entitled 'A Destructive Rice Pest.' The speaker referred almost exclusively to his own observations made in the rice fields during the early spring and late summer. The pest to which reference was made was the bird known locally as the rice bird, and in the north as the bobolink. The habits of the bird in the rice fields of the south, where it stops only on its way to and from South America and the northern United States, where it breeds, were mentioned. Also the extent of the damage done by the birds on their first and second visits to the fields was pointed out. The two methods in use at present for combating this pest were given. These consist in tarring the grain, previous to sowing, and in frightening the birds by the explosions of firearms. The first method is used only in a limited way, the second being the one almost universally employed. The speaker referred to the inefficiency of both methods, and according to his observations the bird is more easily frightened by the passing of shadows than it is by firearms. The possibility of the use of trained hawks for combating this pest was pointed out.

The next and last paper on the program was 'Cultural Studies of a Nematode,' by Dr. H. Metcalf. Under this title there was given an account of investigations into the cause of decay and 'damping off' in a number of different plants. A nematode, a *Fusarium* and several bacteria were found associated with the disease. It was necessary to devise special methods for isolating the nematode. Final results of inoculation indicated that the plant organisms were the direct cause of the decay, but that the nematode played an important part in spreading the infection. By way of illustration living specimens of the nematode were projected on the screen. This paper will be published in the *Proceedings of the American Microscopical Society.*

F. S. Shiver,
Secty.-Treas.

Clemson College, S. C.,
October, 1903.

DISCUSSION AND CORRESPONDENCE.

A VISUAL PHENOMENON.

TO THE EDITOR OF SCIENCE: Dr. Gould's interesting statement concerning a 'hitherto undescribed visual phenomenon' induces me to add the following note. In 1897 during a month's inspection of the Ural region under the auspices of the Russian government, our special train stopped one night on a side track near a station on the Siberian border. Some of our party were attending an entertainment given at some distance and expected to return on foot during the night, which was dark, with a slight drizzling rain. At about ten o'clock I was watching, through a glass window in the rear of the car, a light which I supposed to be a lantern in the hands of my returning fellow travelers. There was no other light visible, and as I looked, it seemed evident that the light was descending the face of a far sloping hill reaching to the railway; but the motion was by a series of lateral jerks first to the right and again to the left, each excursion, however, bringing it, *apparently*, lower and nearer. At first the motion amused me, later it interested me, and when, after steadily observing the phenomenon for a considerable time, I found the light had actually not moved from the spot where I first saw it, I was astonished. In this frame of mind my friend, Professor I. C. White, found me, and not being able to see what I described, doubtless formed an opinion of me as unjust as mine was of the supposed revelers who seemed to be coming home in a decidedly zig-zag course. On my return to Philadelphia I described the phenomenon to Dr. de Schweinitz and others. I found I could reproduce the delusion at will by looking from any dark place at a single light; as, for instance, on a cloudy night from the sea beach at the distant light of a ship on the horizon. Whether looked at with one eye or with two, the light always gives the impression of moving by jerks either sidewise or vertically, but in the former case it always seems to progress slowly downward or upward.

Under the conditions above described the phenomenon appears not to be controllable by the will.

PERSIFOR FRAZER.

SHORTER ARTICLES.

CORTICIUM VAGUM B. AND C. VAR. SOLANI BURT. A FRUITING STAGE OF RHIZOCTONIA SOLANI.

A STUDY of the *Rhizoctonia* of the potato was begun by the Colorado Experiment Station in the spring of 1901. It soon became evident that it is not a sterile fungus and much time has been given to the discovery of a fruiting stage. Observations show that potato plants developed from tubers which are more or less covered with sclerotia of this fungus usually have their subterranean parts overrun with a dark brown cobweb-like mycelium. This covering frequently extends up the green stems from one to three inches above the ground, forming a thin hymenial layer which is usually gray-white in color. This layer does not adhere firmly to the stem and cracks very easily when it becomes dry, consequently it disappears soon after the death of the plant.

The tip of the outermost branches of this hymenial layer become changed into basidia, bearing from two to six sterigmata. The spores are hyaline, and usually ovate in form, with apiculate bases. Fifty spores taken just as they occurred on a green stem gave an average measurement of 10 by 6 μ. But spores after they had fallen averaged 12 by 8 μ. Thus far a pure culture of this fungus has not been obtained directly from spores, but cultures made from the hymenial layer invariably produce a luxuriant growth of *Rhizoctonia.*

The main character of this green stem form agrees with *Corticium vagum* B. & C., but on account of the spore differences and parasitic mode of life, it has been thought wise to make a variety of this form for which Dr. E. A. Burt has suggested *Corticium vagum* B. & C. var. *solani.* It also agrees closely with the description of *Hypnochus solani* Prill & Del, and they may eventually prove to be the same.

FORT COLLINS, COLO., October 19, 1903. F. M. ROLFS.

RESULTS OF THE RESURVEY OF LONG ISLAND, NEW YORK.*

NOTWITHSTANDING Long Island has been many times studied by geologists a considerable

* Published by permission of the Director of the United States Geological Survey.

number of new facts, some of them of quite far-reaching importance, were established by the resurvey of the island by the Division of Hydrology,* United States Geological Survey during the past summer. The more important results are included in the following summary:

1. Long Island, instead of consisting almost entirely of glacial deposits, as was once thought, is now known to possess throughout a large portion of its extent a core of older Cretaceous beds, rising in places to nearly 300 feet above sea level.

2. These Cretaceous beds are not limited to the north shore, as has frequently been supposed, but rise nearly to the tops of the highest hills and extend far to the south, either at the surface, as in the West Hills, or at slight depths beneath the gravel plain on the south side of the island.

3. This Cretaceous nucleus has been found to have been deeply eroded before the deposition of the earliest glacial deposits.

4. The present field work has led to the discovery of greensand in the West Hills, thereby suggesting if not establishing the Upper Cretaceous age of the deposits in question. A considerable thickness of the underlying black and chocolate clays may also be of the same age.

5. The dip of the Cretaceous of the north shore has been determined for the first time, well records showing it to be, in the Oyster Bay region, south 23° east and about 65 feet per mile.

6. The absence of the great masses of Tertiary clays and gravels, assumed to be present by earlier workers, was established beyond question.

7. The yellow gravels formerly assigned to the Tertiary, and considered as constituting a considerable mass overlying the supposed Chesapeake (Tertiary) clays, have been shown to constitute the first of the glacial series (probably Pre-Kansan) of the Quaternary, and normally to underlie the clays instead of overlying them. The gravels were greatly eroded before the deposition of the clays, the deep valley reaching 280 feet below the present sea level which underlies Jamaica, and Jamaica Bay, and which seems to be the logical continuation of the submerged valley shown by the soundings of the Coast and Geodetic Survey off New York harbor, probably being completed if not largely formed at this time.

8. The supposed Chesapeake clays have been differentiated into three distinct formations: the first including the clays near Bethpage and Wyandance being referred to the Cretaceous; the second comprising the buried clays beneath Jamaica and Jamaica Bay belonging to an early interglacial (probably Yarmouth), and the third including East Williston and similar clays to the late glacial (Wisconsin) stage.

9. The portion of the supposed Chesapeake clays beneath Jamaica, Jamaica Bay, etc., were shown to be underlain by glacial gravels of the second ice invasion (probably Kansan), while the clays themselves were proved to have been deposited in the interglacial period (Yarmouth) between the second and third invasions. The area of the clays has been traced out by borings, and the clays themselves shown to represent salt marsh, or submarine deposits formed around the Cretaceous core when the land stood fifty feet higher than at present.

10. The known areas of the Manhasset gravels have been greatly extended to the south and east, having been recognized at Rockaway Ridge, Barnums Island, Bethpage, Half Hollow Hills and eastward beneath Shelter Island, and on the south fluke nearly to Montauk. Its age is probably Iowan.

11. The Manhasset gravels have been proved normally to underlie the moraines instead of resting against them as has sometimes been urged. Actual sections showing the relations were found.

12. Very little of the total height of the ridges is generally due to the morainal deposits themselves, the moraines either resting upon or constituting a coating over the older Manhasset, Pensauken or Cretaceous beds constituting the main mass of the elevations.

* Executive and areal work was in charge of M. L. Fuller, and the underground geology and water problems were in charge of A. C. Veatch.

13. The outwash deposits of the two Wisconsin stages are likewise relatively thin, being generally underlain at slight depths by one or the other of the older formations described.

14. Three groups of artesian wells have been recognized: (1) the deep Cretaceous wells, (2) wells in the Jameco gravels, and (3) shallow wells in the Pleistocene deposits of the north shore.

15. The deep Cretaceous wells are found both on the north and south shores. In both localities the water horizon has a regular southeastward dip. The source of the water in the south shore wells, except in the Barren Island well, is probably in the highlands of the island itself where the beds rise to the surface. In the north shore wells and in the Barren Island well, which perhaps obtains its supply from the same water-bearing horizon, the original source of the water is not yet established, although the problem is under investigation.

16. The Jameco wells obtain their supply from the glacial gravels (Kansan) occupying the deep and well-defined channel extending beneath Jamaica and Jamaica Bay and underlying the thick clays of the succeeding (Yarmouth) interglacial stage. The supply is derived from the ground water entering the gravels under the landward edge of the overlying clay. Because of the coarseness of the gravel the water is given up freely.

17. The shallow north shore artesian wells are generally restricted to the upper halves of the deep reentrant bays, generally at the base of steep slopes. The source of supply is from the ground water of the glacial gravels and sands, the flow taking place by virtue of the freer passage afforded by the wells than by the gravels.

18. The great thickness of the sandy layers of the Cretaceous under the higher portions of the island, the extent to which the Cretaceous water-bearing sands have already been developed and the probability that a number of water horizons have been previously overlooked because of search for a coarse gravel like the Jameco, makes the recommendation made by Professor C. S. Slichter regarding the advisability of sinking deep wells with casing perforated at each water-bearing horizon particularly pertinent.

M. L. FULLER,
A. C. VEATCH.

CURRENT NOTES ON METEOROLOGY.

BLOOD COUNTS AT HIGH ALTITUDES.

Nos. 8 and 9 of Vol. III., *Bulletin of the Hadley Climatological Laboratory of the University of New Mexico,* deal with 'Cold as a Causal Factor in the Blood Changes due to High Altitude,' and with 'Further Observations on Increased Blood Counts due to High Altitude.' The first paper is by John Weinzirl, M.S., and the second, by the same author with the cooperation of C. E. Magnusson, Ph.D., is a study the prosecution of which was aided by a grant from the Elizabeth Thomson Fund. The fact of an increased number of red blood corpuscles at high altitudes is well known, and has been investigated by Bert, Egli-Sinclair, Viault, Müntz, Egger and others. By means of blood counts in the cases of human beings and of rabbits, the authors of these papers come to the conclusions that cold is an important, though not the only, factor in producing blood changes at high altitudes, and that the increase in the number of red corpuscles due to altitude is temporary (as, it should be noted, has already been shown by several writers), this temporary increase being very largely due to the change in the temperature and not to the diminished pressure.

WEST INDIA HURRICANES.

ON the 'Pilot Chart of the North Atlantic Ocean' for September last there is a brief but well-arranged summary of the most important facts regarding West India hurricanes, prepared by James Page, of the United States Hydrographic Office (reprinted from H. O. Publication, No. 86). Of 56 hurricanes recorded by the Hydrographic Office between 1890 and 1900, 41 occurred in September and October. Instead of the old 'Eight Point Rule,' which is now known to hold only for the central portion of the storm, seamen are at present instructed that 'six

points (67° 30′) have been accepted as the value most frequently met in actual practice.' Taking this value, the following rule approximately fixes the bearing of the storm center from a vessel in the northern hemisphere: Stand with back to the wind; the storm center bears six points to the observer's left. It is, nevertheless, perfectly clear that the angle between the wind direction and the gradient often differs considerably from this average value, not only in different storms, but also in different parts of the same storm. No simple rule of thumb can ever replace the careful judgment of the individual seaman who has a good understanding of the law of storms, and who makes an intelligent use of his own local meteorological observations.

CLOUD OBSERVATIONS AT SIMLA.

Cloud observations and measurements were made at Simla during the twenty months from June, 1900, to January, 1902, under many disadvantages of unfavorable weather and lack of time on the part of the observers. Photogrammeters were used, but only about 47 fairly good observations were obtained during the period. The average heights above sea level, and above Simla, of the clouds for the year were as follows:

Cloud.	Above Sea Level.	Above Simla.
Cirrus	37,664 feet.	30,440 feet.
Cirro-cumulus	25,083 "	17,859 "
Cumulus	14,528 "	7,304 "
Fracto-cumulus	13,143 "	5,919 "

These heights do not agree very closely with those previously obtained at Allahabad (Indian Met. Memoirs, Vol. XI.). Cirrus clouds are most frequent at Simla between 16,000 and 40,000 feet above the earth's surface, and the other forms of cloud between 16,000 feet and the surface. (W. L. Dallas: 'Report on Cloud Observations and Measurements at Simla,' Ind. Met. Mem., XV., Part II., Calcutta, 1903.)

R. DeC. Ward.

SANITATION AND THE PANAMA CANAL.

A small committee representing the American Medical Association, the American Association for the Advancement of Science and the New York Academy of Medicine, called on President Roosevelt, November 25, for the purpose of presenting resolutions passed by the organizations mentioned, urging the President to appoint upon the Panama Canal Commission a medical man who shall be an expert sanitarian.

The committee consisted of Drs. Musser, of Philadelphia, Welch and Osler, of Baltimore, and Bryant, of New York, representing the American Medical Association; Dr. Howard, of Washington, representing the American Association for the Advancement of Science; Dr. A. H. Smith and Dr. Loomis, representing the New York Academy of Medicine.

The resolutions were presented to President Roosevelt by Dr. Welch, who made a brief statement urging that the sanitary problem connected with the building of the canal was quite as serious as the engineering problem and pressing the point that a medical expert should be a member of the commission rather than a servant of the commission.

The views of the joint committees were received by the President with interest, but while he was evidently perfectly aware of the enormous importance of the sanitary problem connected with the project, he gave no assurance that he would adopt the specific suggestion of the committees.

RESOLUTIONS OF THE FACULTY OF CORNELL UNIVERSITY ON THE DEATH OF PROFESSOR ROBERT H. THURSTON.

The faculty and instructing staff of Cornell University wishing to give voice to the sentiments evoked by the death of their colleague and friend, Professor Robert Henry Thurston, Director of Sibley College, have directed the following to be entered upon the records of the university faculty and communicated to his family.

Professor Thurston came among us in 1885 when the university had barely entered upon its present era of development, and the college over which he came to preside was still small in numbers and poor in equipment. During the eighteen years of his labors he witnessed the progress of the university in all of its de-

partments and the remarkable growth of Sibley College. His own contribution to this splendid result can hardly be over-estimated. To his wise and farsighted policy and his tactful and efficient administration is due in greatest measure the development of Sibley College, which now constitutes the largest unit in our university organization and holds an assured place among the foremost technical schools of the world.

In all his relations to general university problems he exhibited the spirit of the scholar and the wisdom of the man of affairs. Serene in temper, sound in judgment, swift and certain in action, he justly exercised a weighty influence in all our counsels.

As a colleague he exhibited an interest in all good learning that bespoke the true scholar and the generous fellow-worker.

As a friend and companion he manifested a cordial sympathy that attracted all who knew him and held them in the bonds of an increasing affection.

In all the relations of life he moved upon the higher levels and showed forth the better qualities of our nature.

His loss falls heavily upon us, his colleagues and friends; upon the college whose head he was; and upon the university in whose history he has borne a distinguished part. It falls most heavily upon his family, whose grief we share, and to whom we desire to express our profound and sincere sympathy.

T. F. CRANE,
E. W. HUFFCUT,
W. F. DURAND,
Committee.

ITHACA, N. Y.,

SCIENTIFIC NOTES AND NEWS.

A COMMEMORATIVE number of *The American Journal of Psychology* has been issued, in honor of President G. Stanley Hall on the occasion of the twenty-fifth anniversary of his attainment of the doctorate of philosophy. The volume contains twenty-six papers by colleagues and former students and extends to 434 pages. A portrait of President Hall is given as a frontispiece. The dedication reads "To Granville Stanley Hall, founder of the first American laboratory for experimental psychology and of the first American journal for the publication of the results of psychological investigation; pioneer in the systematic study of the mental development of children and the application of its results to educational practice; ardent inspirer of others in the zeal for new knowledge—in commemoration of the twenty-fifth anniversary of his attainment of the doctorate in philosophy, this collection of papers is dedicated conjointly by colleagues and former pupils."

DR. HANS GADOW, Strickland curator of the University Museum and lecturer on advanced morphology and vertebrata at Cambridge University, England, has accepted an invitation of the Lowell Institute, Boston, to give a course of six lectures beginning March 29, 1904, on 'Coloration of Amphibians and Reptiles.' Dr. Gadow will probably give other popular lectures on zoological subjects while he is in this country.

DR. M. E. JAFFA, of the University of California, was elected president of the Association of Official Agricultural Chemists at their recent meeting in Washington.

DR. E. H. RUEDIGER, of the Memorial Institute for Infectious Diseases, Chicago, has been appointed assistant in the Serum Institute, Manila, P. I.

OSMOND E. LEROY, of the Geological Survey of Canada, has been appointed geologist to the Chinese Department of Mines, and leaves for Shanghai this month. Mr. Leroy is a graduate of McGill University and was assistant in geology in that institution for several years. During the past two seasons he has been engaged with Dr. Barlow in a detailed geological study of the nickel areas in the district about Sudbury.

MR. W. M. MACMILLAN, of St. Louis, will start this week for Egypt in order to explore the course of the Blue Nile. The party will embark in launches at Khartum and proceed to the furthest navigable point, where it will land and continue the explorations in the direction of Lake Rudolf.

PROFESSOR W. J. HUSSEY, of the Lick Observatory, has for some time been engaged in

astronomical observations at Canoplas, N. S. W.

COMMANDER ROBERT E. PEARY, U.S.N., Lieut.-Commander William S. Sims, Lieut. H. A. Bispham and Surgeon Henry G. Beyer, U.S.N., who have been inspecting the barracks system of British and German naval stations with a view to determining the advisability of building similar barracks at the navy-yards in this country for the housing of seamen to take the place of receiving ships, have returned to America.

DR. R. D. MURRAY, of the Public Health and Marine Hospital Service, died in Laredo, Texas, on November 22, at the age of sixty-four years. His death was the result of the runaway accident noted in the last issue of this journal.

MR. ANDREW CARNEGIE had offered to give $300,000 to New Haven for a public library if the city would appropriate $30,000 a year to maintain it. It will be accepted by the city, but legislative power will first have to be obtained.

THE Warren Triennial Prize of the value of $500 will be awarded next year for a research on some topic in physiology, surgery or pathology. Particulars may be obtained from Dr. H. B. Howard, Massachusetts General Hospital, Boston.

THERE will be a civil service examination on January 5, 6 and 7, 1904, for mammal taxidermist in the U. S. National Museum at a salary of $900 a year.

THE American Society of Mechanical Engineers will hold its forty-eighth annual meeting in New York City on December 1–4. President J. M. Dodge will deliver an address on 'The Money Value of Technical Training.'

THE American Historical Association and the American Economic Association will hold their annual conventions in New Orleans, La., on December 29, 30 and 31.

THE Röntgen Ray Society meets at the University of Pennsylvania on December 9 and 10.

THE fourteenth International Congress of Americanists will meet at Stuttgart from August 18–23, 1904. Dr. Karl von den Steinen is president of the committee on organization. The vice-presidents are Count von Linden and Dr. Eduard Seler. The subjects to be discussed by the congress relate to (*a*) 'The Native Races of America; their Origin, Distribution, History, Physical Characteristics, Languages, Inventions, Customs and Religions'; (*b*) 'The Monuments and the Archeology of America'; (*c*) 'The History of the Discovery and Occupation of the New World.' Communications may be oral or written, and in English, German, French, Italian or Spanish. The time allowed for each paper shall, as a rule, not exceed twenty minutes; but exceptions may be made for subjects of particular interest and general importance. For the discussions the limit of time is five minutes. All papers presented to the congress will, on the approval of the bureau, be printed in the volume of Proceedings. Members are requested to send in the titles of their papers to the general secretary as soon as possible. Abstracts, which may not exceed 1,000 words, of any paper accepted for the program, should be sent in before July 1; they will be printed in the daily bulletin during the session. Applications for membership in the congress, the cost of which is $3.00, should be made to the secretary, Dr. Kurt Lampert, Archivstrasse, 3., Stuttgart.

THE steamship *Gauss* has safely arrived at Kiel after its Antarctic expedition.

THE Antelope House at the New York Zoological Park was open to the public on November 26. The building, which is 142 x 78 feet, has been erected at a cost of about $80,000.

The British Medical Journal states that the botanical part of the Museum of Natural History of Owens College has just been enriched by the gift of one of the governors of the college, Mr. J. Cosmo Melvill, of this General Herbarium of the World. It embraces one third of all known plants, about 40,000 species, exhibited through half a million specimens, gathered from most parts of the world, arctic, temperate and tropical. It is one of the three last private herbaria existing in Great Britain, and the only one of the three

which extends its area beyond the palearctic region. Of the 7,500 recognized genera of plants it contains 5,000, and many subgenera.

THE Geophysical Institute at Göttingen, which is the only one of the kind in Germany, is about to be enlarged by an additional wing.

THE London *Times* states that Dundee whalers which have returned from Davis Strait make reports concerning the Ericksen (Danish) and Amundsen (Norwegian) expeditions. On June 26 the whalers *Eclipse*, Captain Milne, and *Diana*, Captain Adams, met at Dalrymple Rock, near Smith's Sound, where they had a rendezvous with Captain Amundsen. They found no signs of the explorer, but by arrangement left a large quantity of stores. Since he left Norway nothing has been heard of Amundsen. He was expected to touch at the Danish settlements on the west coast of Greenland. The past summer is memorable in whaling records, the winds and ice conditions rendering the passage to the north extremely hazardous. It is feared that disaster may have overtaken Amundsen's little craft, but experienced whalemen state that if he has kept to the west side of the straits he may have escaped the great ice. When in the neighborhood of Dalrymple Rock, Captains Milne and Adams fell in with Ericksen and his company. They were in Saunders's Island, and were in a pitiable state of destitution. Count Moltke, the artist of the expedition, was very ill, and the explorers, who were in company with several natives, inhabited an old and tattered tent. Food, but for a supply of eggs, was very low, and they had only one gun. They had abandoned their boat and all but one of their sledges at the northern part of Melville Bay. The captains were unable to furnish them with a boat or to convey them to Greenland. They, however, gave them wood to build a boat, some ammunition, potatoes, butter and other stores. The captain now expects that they may not have attempted to leave, as in the terrific weather that followed it is almost certain that they would have perished; and it is surmised that they elected to stay with the Eskimos. They would quickly fall in with Amundsen should his party not have come to grief. The whalemen consider it almost hopeless that they will succeed in making the Danish settlement this winter.

THE forthcoming session of the Royal Geographical Society, says the London *Times*, will begin on November 4, a week earlier than is usual. This, we understand, is due to the fact that Sir Frederick Lugard, who has promised to give the opening paper of the session, on northern Nigeria, is due to leave England early in November to resume his work in that part of the empire. The second paper, on November 10, will be by Commander R. E. Peary, who will give an account of his North Polar explorations and attempts to reach the North Pole, during the years 1898–1902. The next meeting, on November 23, will be occupied by a paper by Colonel C. C. Manifold, who will give an account of his recent explorations and survey work in western China, and expound his views on the economic development of that region. At the meeting on December 14 Colonel Sir Thomas Holdich will describe some of the results of his work among the Patagonian Andes, when carrying out the delimitation of the frontier between Chile and the Argentine Republic. The arrangements for the meetings of the society after Christmas are more or less provisional. Papers, however, may be expected by Colonel P. H. M. Massy, on his seven years' journeys in Asia Minor; by Captain Philip Maud, R.E., on the exploring expedition along the southern Abyssinian border, organized by Mr. Butter, who obtained Captain Maud's services as surveyor. It is possible also that Sir William Garstin may be able, before the conclusion of the session, to give the society an account of the results of his recent investigation of the Nile basin. A popular exposition of the views at present entertained with regard to the Gulf Stream may be expected from Mr. H. N. Dickson, while Mr. Keith Lucas may deal with his recent investigations among the lakes of New Zealand. It is hoped that Lieutenant Ernest Shackleton may be able to tell, in the form of a Christmas lecture to young people, of some of his adventures in the Antarctic regions,

with many lantern illustrations. It is hardly to be expected that the *Discovery* will reach home in time to enable Captain Scott to give an account of the work of the expedition. This is more likely to be the leading event of the following session.

A Reuter telegram from Vienna says: As a result of a long conflict between the Anti-Semitic members of the Landtag and Count Kielmansegg, governor of Lower Austria, on the one hand, and the general body of Vienna physicians and university professors on the other, the members of the Vienna Medical Chamber, which is entrusted with the professional control of the doctors in this city, resigned *en masse*. The conflict began ostensibly over the question of vivisection, several members of the Landtag accusing the doctors of performing experiments on animals in a manner contrary to the provisions of the Vivisection Law. The doctors allege that the whole agitation is fostered by the Anti-Semites, who are generally hostile to science, and that the fact that large proportion of Vienna doctors are Jews tended greatly to increase the hostility of the Anti-Semites.

The Bureau of Agriculture of the Philippines is organized with the following officers: F. Lamson-Scribner, Chief of Bureau; Seth Bohmanson, Chief Clerk; Harry H. Dell, Director of Animal Industry; A. P. Hayne, Director, Agricultural College and Experiment Station, Negros Occidental; A. J. Washburne, Manager of Stock Farm; Geo. M. Havice, Superintendent of Government Farm at San Raman, Mindanao; Wm. S. Lyon, in charge of Seed and Plant Introduction; Harry T. Edwards, Fiber Expert; Thomas Hanley, Expert in Tropical Agriculture; Wilfred J. Boudreau, in charge of Rice Investigations; James H. Shipley, Expert in Plant Culture; Zalmon K. Miller, Expert in Farm Management and Machinery; Thomas L. Richmond, Superintendent of Experiment Station in Manila.

UNIVERSITY AND EDUCATIONAL NEWS.

The president and fellows of Harvard University have voted to fix the number of Austin Teaching Fellowships at twenty-four. These fellowships are not subject to application like other fellowships and scholarships, but are treated like assistantships and annual instructorships as regards the manner of appointment. Of the twenty-four fellowships, twenty are under the faculty of arts and sciences, and four under the faculty of medicine.

The special course in agriculture, which has been given at the Scientific School of Yale University for twenty-five years, has been discontinued on account of the retirement of Professor Brewer.

The Prussian Ministry of Public Instruction is preparing a work on German education for the St. Louis Exposition. The book is to contain a complete account of German instruction in all its branches at the present time, and also an account of its historical development. There will be over a hundred contributors, the introduction being written by Professor Paulsen.

The University of Edinburgh has received a gift by Dr. Henry Barnes, Carlisle, of MS. letters of Boerhaave.

Messrs. W. R. Ransom and E. C. Froelich have been appointed instructors in mathematics in Harvard University.

Paul B. Bird has been appointed instructor in marine engineering at Cornell University.

Leo R. A. Suppan, Ph.G., formerly of the Rolla School of Mines in Missouri, has been elected instructor in chemistry in the St. Louis College of Pharmacy. He thus becomes associated with the recently elected professor of chemistry, Dr. Charles E. Caspari.

Mr. W. E. Williams, B.Sc., of the University College of North Wales, has been elected fellow of the University of Wales for 1904. He proposes as his subject of investigation, to be carried on at Glasgow University, 'The Effect of Magnetization on the Electrical Properties of Nickel Steel.'

Mr. Bertram Hopkinson, M.A., of Trinity College, has been elected professor of mechanism and applied mechanics at Cambridge, in place of Professor J. A. Ewing, resigned. Mr. Hopkinson is the son of the late Mr. John Hopkinson, the engineer.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 11, 1903.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

UNIVERSITY REGISTRATION STATISTICS.

A COMPARISON of the figures on the table with those for 1902 (SCIENCE, N. S., Vol. XVI., No. 417, December 26, 1902, p. 1022) will show that at the majority of the institutions given in the table the number of students enrolled during the present academic year represents an increase over the registration of last year. Several institutions have suffered a slight decrease in attendance and the general gain is not as marked as it was last year, yet on the whole the figures point to a normal and healthy growth, and the steady forward movement in the progress of higher education has continued virtually unchecked. Undoubtedly the present economic conditions of the country are partially accountable for this slight falling off in the percentage of general increase, but the effect, if any, can scarcely be regarded as serious, and would, in the ordinary course of events, not be felt keenly until next year.

The statistics given on page 738 are, with few exceptions, approximately as of November 1, 1903, and relate to the registration at twenty of the leading universities throughout the country. In order to avoid all misapprehension, it should be distinctly understood that the higher institutions of learning here represented are not necessarily the twenty largest or the twenty leading universities, but all are in-

	California.	Chicago.	Columbia.	Cornell.	Harvard.	Illinois.	Indiana.	Johns Hopkins	Leland Stanford, Jr.	Michigan.	Minnesota.	Missouri.	Nebraska.	Northwestern.	Ohio State.	Pennsylvania.	Princeton.	Syracuse.	Wisconsin.	Yale.
College Arts, Men....	490	569	493	} 726	2077	302	923	158	800	742	470	284	330	371	271	} 514	732	} 942	732	1251
College Arts, Women	943	812	399		444	305	596	......	478	635	745	133	608	421	200		......		525	......
Scientific Schools*...	840	......	719	1317	547	797	§	......	§	801	524	253	382	§	720	540	586	264	705	845
Law..........	80	89	384	235	734	140	95	......	198	823	430	180	170	210	159	324	......	125	194	255
Medicine..........	118	147	669	355	380	669	25	278	......	448	265	80	59	512	......	472	......	140	......	144
Agriculture..........	†	......	......	135	19	285	......	......	......	......	700	67	98	......	151	......	......	......	496	......
Art..........	206	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	49	......	33
Dentistry..........	112	......	......	......	115	585	......	......	......	74	140	......	19	500	......	363	......	......	......	......
Divinity..........	......	177	......	......	50	......	......	......	......	......	......	......	......	150	......	......	......	......	......	98
Forestry..........	......	......	......	......	......	......	......	......	......	......	......	......	......	......	21	......	......	......	......	64
Music..........	......	......	......	......	......	93	......	......	......	......	......	......	320	318	......	22	......	579	227	80
Pharmacy..........	84	......	......	......	......	183	......	......	......	56	46	......	......	217	47	......	......	......	32	......
Teachers College......	‡	95	624	......	......	......	......	......	......	......	......	84	......	......	......	165	......	‡	......	......
Veterinary..........	......	......	......	85	......	......	......	......	......	......	......	......	......	......	84	75	......	......	......	......
Graduate Schools.....	207	442	620	177	394	104	73	194	86	69	75	42	88	43	27	195	116	46	95	346
Summer Session.......	868	2244	1001	470	1392	225	479	......	18	523	175	639	191	......	104	......	......	52	400	......
Other Courses..........	32	......	17	157	......	72	......	65	......	......	......	......	......	100	35	......	......	110	......	15
Deduct Double Reg..	(290)	(429)	(369)	(219)	(139)	(99)	(577)	(1)	(210)	(245)	(20)	(222)	(18)	(102)	(109)	(26)	......	(100)	(185)	(141)
Grand Total..........	3690	4146	4557	3438	6013	3661	1614	694	1370	3926	3550	1540	2247	2740	1710	2644	1434	2207	3221	2990
Teaching Staff.......	342	197	585	420	549	399	71	150	128	182	295	106	220	304	140	308	108	180	225	325

*Includes schools of engineering, chemistry, architecture, mining, and mechanic arts.
† Included in scientific schools.
‡ Included in college statistics.
§ Included in college statistics.

stitutions of national repute. The figures have been obtained from the proper officials of the universities concerned, and are as accurate as statistics of this nature can be made. Changes are constantly taking place in the enrolment at most of these institutions, but they are not far-reaching enough to affect the general result.

According to the revised figures of last year, the nineteen universities enumerated ranked as follows:

Harvard, Columbia, Chicago, California, Michigan, Minnesota, Cornell, Illinois, Wisconsin, Northwestern, Yale, Pennsylvania, Nebraska, Syracuse, Indiana, Leland Stanford, Missouri, Princeton, Johns Hopkins. Comparing this with the present order, we shall find that there has been no change in the relative positions of the three largest universities, Harvard, Columbia and Chicago, but that Michigan has passed California, while Illinois has passed both Minnesota and Cornell. Wisconsin occupies the same position as last year, but Yale has passed Northwestern. Pennsylvania, Nebraska and Syracuse follow in the same order, Ohio State University, which is inserted for the first time this year, preceding Indiana, Missouri, Princeton, Leland Stanford and Johns Hopkins in the order named. The fact must not be lost sight of that numbers are not necessarily a criterion of general excellence or high standards, features with which this article does not attempt to deal. However, the fact that a university like Johns Hopkins is included in the statistics will prove that mere numbers have not unduly influenced the selection of the institutions here tabulated.

As far as the changes in the enrolment of the different universities are concerned, Harvard shows a considerable net increase, due almost entirely to the expansion of the summer session from 945 in 1902 to 1,392 in 1903. This increase must be attributed in large part to the Convention of the National Educational Association held in Boston early in July. Harvard's law school shows a gain of almost 100, thus eloquently demonstrating that increased standards of admission to the professional schools are not kept waiting long for merited recognition from the student body.

To be sure, the Harvard Medical School shows a loss of 65 as compared with last year, owing in part to the operation since 1901 of the requirement of a baccalaureate degree, or its equivalent, for admission, but we shall see below that this loss in the medical school enrolment may be due to other causes. Harvard College and the Lawrence Scientific School show a slight falling off over last year, while there has been a gain in the divinity school and the graduate faculties.

At Columbia also the increase in the total enrolment is due almost entirely to the growth of the summer session, the attendance at which increased from 643 in 1902 to 1,001 in 1903. The registration of the law school shows a falling off of 81, due to the requirements of the baccalaureate degree for admission for the first time this fall. The attendance at the school of medicine has decreased over 100, a loss that can in large part be attributed to increased standards for admission. With the opening of the present academic year, higher entrance requirements went into effect, whereby the minimum condition for admission to this faculty consists not, as heretofore, in the passing of examinations conducted by the regents of the university of the state in certain specified subjects, and the obtaining thereby of a medical student's certificate, but in the passing of an examination conducted either by the College Entrance Examination Board or by the Committee on Entrance Examinations of Columbia University. In every case the increase in requirements has had a gratifying effect on the quality of the first-year class. The graduate schools of Columbia University are growing very rapidly and show an increase of more than 100 over 1902. The extension students, of which there were 1,196 in 1902, have been omitted in this year's table, but even if the extension students were included, Columbia's registration would not be as large as that of Harvard.

The figures of the University of Chicago point to a slight decrease in the total enrolment, most of which is due to a falling off in the college and the faculty of medicine. The summer session shows a loss of over 100, but, as is well known, the summer session at the University of Chicago does not bear the same relation to the remaining terms as it does at Harvard or Columbia and most of the other institutions here represented, being regarded as a regular semester fitting into the scheme of the entire year's work.

The attendance at the University of Michigan has increased somewhat over last year, the largest gains being found in the scientific schools and the summer session. The faculties of law, dentistry and pharmacy all show a falling off. Of the 448 medical students, 66 are enrolled in the homeopathic division. In the case of the University of Michigan, as well as of several others, no accurate figures could be obtained for the number of summer session students who returned for work in the fall and who should be deducted under double registration. In all such cases the deduction is based upon a fair estimate.

The increase at the University of California is only slight, there being a loss in medicine and dentistry and in the college and scientific schools, which loss, however, is more than compensated for by slight gains in other departments.

In the case of the University of Illinois the gain of over 700 must be attributed chiefly to the fact that the Chicago College of Dental Surgery, formerly an independent institution, became a part of the university at the beginning of the year. However, there has been considerable gain in the scientific school and the department of agriculture, whereas the increase in the

attendance at the medical school is scarcely worth mentioning.

The increase at the University of Minnesota is small and is to be found almost entirely in the department of agriculture. The slight decrease in the number of male college students is more than made up by the increase of the number of women enrolled in the college. The law school has remained stationary, the scientific schools show an increase, and the medical faculty, the departments of dentistry and pharmacy, the graduate schools and the summer session, show a falling off in attendance.

At Cornell there has been a slight increase in the total attendance, and the typhoid epidemic of last year has apparently not affected the attendance to any great degree. There has been a decrease in the college, the faculty of medicine and the graduate schools. The department of forestry has been abolished and the summer session shows a decrease over last year. In the case of Cornell, also, the total is not quite accurate, inasmuch as no exact figures were given with regard to double registration.

Wisconsin shows considerable gains all along the line, with the exception of the graduate schools and the law faculty, the total enrolment being more than 300 in excess of that of last year.

The attendance at Yale has also increased over last year, the gains appearing in the college, the Sheffield Scientific School and the department of forestry. The medical and the graduate schools have remained stationary, while the law school and the schools of art, music and divinity show a decrease in enrolment.

There has been a decrease in the attendance at Northwestern University, a considerable portion of which is to be found in the faculties of medicine and dentistry. This decrease in attendance at the medical school may be attributed to two causes, namely, increased tuition and higher standards of admission. The 100 students listed under 'Other Courses' are students in oratory. The college and the law school show an increase, while the graduate schools, the divinity school and the department of pharmacy have remained stationary.

Pennsylvania shows a slight increase in the net total enrolment, due almost entirely to gains in the college and scientific schools. Law and dentistry have fallen off, whereas medicine and the graduate schools have remained stationary. The 165 students appearing under 'Teachers College' are attending courses for teachers.

At the Universities of Nebraska and Indiana there has been a slight decrease; Leland Stanford, Jr., has remained virtually stationary; while Syracuse, Missouri, Princeton and Johns Hopkins show an increase over the attendance of last year.

Comparing the attendance in the various departments with the figures for last year, the most striking fact is the decided decrease in the schools of medicine all along the line. In a number of institutions increased requirements have had something to do with this loss, yet the higher standards of admission alone can not be held accountable. The question arises whether this loss may not be due to a circumstance to which Professor Brouardel, of Paris, points in a recent investigation. He claims that the superabundance of physicians going hand in hand with a shortage of patients must be attributed to a decrease in the number of illnesses, a decrease due to the application of modern methods of preventive medicine.* The increase in the cost of procuring a medical education no

* Cf. Walter B. James, 'The Old and the New Medicine,' *Columbia University Quarterly*, Vol. VI., No. 1, p. 13. At McGill University, Montreal, Canada, the enrolment in the medical school also shows a decrease.

doubt is partly responsible, as well as the long time required for a thorough course.

The number of scientific students is still on the increase. In most of the other faculties there have been no consistent gains or losses, the decrease in certain universities being made up by a corresponding increase in others. Columbia University still has the largest enrolment in the graduate schools, with Chicago second, Harvard third and Yale fourth. The University of Michigan continues to head the list in the number of law students, followed by Harvard, Minnesota and Columbia in the order named. Although the attendance at the Columbia medical school has suffered a loss of over 100, this university still has the largest enrolment of any of the medical schools enumerated, but is closely followed by Illinois, with Northwestern and Pennsylvania occupying third and fourth places respectively.* As to the scientific schools, Cornell is in the lead, with Yale second, California third and Michigan fourth. Harvard has by far the largest collegiate enrolment and also had the largest summer session last year. As to the relative ranking of the teaching force in the largest institutions, Columbia now occupies first place, with Harvard second, Cornell third and Illinois fourth.

RUDOLF TOMBO, JR.,
Registrar.
COLUMBIA UNIVERSITY.

* The table credits Columbia and Illinois with 669 students each, but in the case of Columbia there are a number of fourth-year college students enrolled in the medical school who do not appear among the 669, but in the primary registration under the college.

VARIATIONS INDUCED IN LARVAL, PUPAL AND IMAGINAL STAGES OF BOMBYX MORI BY CONTROLLED VARYING FOOD SUPPLY.

ONE of the races of the mulberry silkworm, *Bombyx mori,* has been the subject of experiments directed toward a determination of the exact quantitative relation which quantity and quality of food bear to the development and variations of the individual insect and its progeny. Such an experiment, on the face of it, might seem to be a laborious task having no further justification than the superfluous, though specific, demonstration of the axiom that the well-nourished are the well-developed. The writers will not hesitate, however, to put on record authentically determined data showing just how definite and constant is the relation for one animal species between varying nutrition and variations. As a matter of fact the experimental breeding and rearing and the accumulation of quantitatively determined data refer to several problems besides the few discussed in this paper. The successive years of breeding have left us at the present moment with a large number, several thousand, of eggs, due to hatch next March, which are the results of selected mating, and of which the ancestors for two or three generations are known, quantitatively described, and preserved for reexamination, if necessary. In addition to the knowledge of the structural and physiological characters (duration of various life-stages, etc.) of these ancestors, the quantitatively determined life-conditions, normal and experimentally varied, are known. These thousands of the fourth generation should afford us exact evidence, for this animal species, touching the prepotency of sex, of sports, of particular characters and of vigor, as well as evidence regarding fertility in relation to age, and evidence concerning genetic and physiological selection.

The present statement is limited to an outline of the results of only those experiments relating directly to the influence exerted by varying conditions of food supply.

The insect, *Bombyx mori,* has a complete metamorphosis, taking no food as an adult,

so that the experimental control of the feeding has been necessary only during the larval or 'silkworm' stage. The larval life is subdivided into five stages clearly set off from one another by the intervening moults, of which there are normally four, and these substages have been useful when an alteration of food conditions during a sharply defined shorter time than the entire larval life was desirable.

The change in quality of food has consisted in a substitution of lettuce for the silkworm's proverbial mulberry diet. The change in quantity of food has consisted in altering the amount of mulberry served to the larvæ, the control of which has been secured as follows: It has been determined through experience with normal larvæ that each will consume a certain amount of food in a certain number of hours (increasing in amount with the increasing age and size of the larva), this amount representing the optimum amount of food for the normal individual and necessitating as many daily meals as are required to keep any but the moulting larva constantly supplied with fresh food. This amount determined, a tolerably definite small proportion of the optimum amount has been allotted the individuals which were sentenced to short rations, which, roughly speaking, might be listed as one quarter the optimum amount during earlier stages and one eighth during the late larval stages. This one fourth, one eighth or whatever it may have been numerically, was, at any rate, as small an amount of food as was compatible with mere life. Our object was not that any of the larvæ should die of starvation, but that they should live to tell the tale of the results of diminished nourishment. This difference in feeding was not regulated by lengthening the intervals between meals, but by giving the under-fed but a scanty share of the quantity afforded the well-fed individuals at each meal. There were no intervals between the meals of the well-fed, whereas there were lengthy intervals between the meals of the under-fed, because the under-fed very promptly ate their allotments and were, therefore, without food during the remainder of the interval preceding the next feeding time.

These experiments have extended over a period of three years, covering as many generations of the insect. The data gathered (being the measurements, weight and duration of each larva in each of its five stages; the time of spinning, weight of silk and weight and duration of each pupa; and the weight, size, pattern and fertility of female of each imago) furnish material, then, for a study of the effects of underfeeding upon individuals during a single generation (the 1903 generation or that of 1902 or 1901), during two successive generations (1901–02 or 1902–03), and two alternating generations (1901, 1903) and during three generations (1901–03), a control lot having been carried for each experimental lot so that what is modified may confidently be distinguished from what is normal.

The practice of isolating the larvæ individually has been observed for some of the lots of 1901 and for all the individuals in all the lots of 1902 and 1903. The necessity for such an arrangement will be appreciated by making comparison of a lot of isolated individuals with a lot of individuals getting a living in a single tray where competition became a factor, the amount of food per capita being identical for the two lots.

In 1901, two lots, each consisting of twenty larvæ, were reared on very short rations, the first lot having its individuals isolated, the second having all of its individuals in a single tray. The amount of food per capita allowed these two lots was identical—an amount calculated to produce dwarfs. After the second moult,

when the larvæ were about nineteen days old, we found the first lot very uniform and the second very unequal in size, the difference between the heaviest and lightest in the first lot being 19 mg. as against 45 mg. in the second. To the second lot belonged the smallest individual among the season's entire generation of worms, while, on the other hand, this competitive lot boasted one precocious individual weighing more than the average among other lots of well-fed worms, holding, indeed, third place among the 'heavy weights' of the season.

The records of size, when these larvæ had finished feeding and were ready to spin, show the final results of the competitive and non-competitive life of the under-fed lots: in the first lot, with the individuals isolated, the difference in weight between the largest and smallest was 229 mg., in length 8 mm.; in the second, with the individuals together and competing, the difference in weight was 901 mg., in length 22 mm. These figures speak for themselves and offer a pretty illustration of the non-combative but equally strenuous struggle for existence which occurs when an inadequate food supply results in a struggle between closely allied and hence competing forms, to the prosperity of some and the decline of other members of the species thus divided against itself.

A second reason for isolating the larvæ individually is that individual records extending over long periods of time are not otherwise possible. The data consist of individual records concerning Characters, in part enumerated below, of 630 individuals of *Bombyx mori* belonging to three generations (1901–03).

The studied characters which are pertinent to the present discussion may be listed as follows:

1. Those relating to *size* as indicated by weight of larva, of the cocooned pupa, of the cocoon or pupa alone and of the adult upon emergence.

2. Those relating to the prompt performance and normal occurrence of physiological functions such as the moulting and spinning of the larva and the emergence of the adult.

3. Fertility in so far as it is indicated by the number of eggs laid.

4. Mortality among the variously nourished lots as indicated by the death rate.

Some generalizations already reached through the study of the data may be briefly summarized as follows:

1. As to the substitution of lettuce for mulberry as silkworm food, the experiment has been tried only with the generation of 1903, and that on a rather small scale. The 'worms' have adapted themselves to this change of diet to the extent of living successful individual lives and of producing eggs which bear all the earmarks of fertility, that is, have gone through the normal change of color from yellow to gray, the result of beginning development. The eggs will not hatch until March, 1904. The young larvæ adopted the unusual diet very reluctantly, but in later life these same larvæ, 'educated' to its use, ate lettuce with a relish which would rival that displayed by the normal larva with its mulberry leaf.

The most striking variation induced by this lettuce regimen was that the time consumed by the metamorphosis was double the time appointed for that of the normal mulberry-fed larva—being three months as compared with six weeks for the latter. In the commercial world this fact would offset the advantage of the lettuce, as a cheaper food and as one available at all seasons, by demanding twice the labor that is required to rear to spinning time larvæ fed on mulberry. Thus it appears that the lettuce experiment can not be of economic value to sericulture unless it should prove

that lettuce-made silk is worth the cost of double labor.

The other variations noted among the lettuce-fed 'worms' have to do with the larva and cocoon. All of the lettuce-fed larvæ appeared to be unusually 'thin skinned,' the body wall being stretched and shiny. The larvæ were at all stages characteristically heavier than mulberry-fed larvæ, each of them weighing at spinning time as much as, and two of them weighing 400 mg. more than the heaviest of the mulberry-fed. The weights of the cocooned pupæ were somewhat above the average among the mulberry-fed, a fact due to the large pupa rather than to the amount of silk in the cocoon, as was demonstrated by weighing cocoon and pupa separately, whereupon it was found that the cocoon was, on the average, but one half as heavy as that of the average among the mulberry-fed, in some cases falling as low as two fifths of the mulberry cocoon's average weight, and in no case rising above three fifths. The silk appears to be less strong and elastic than that of the mulberry-made cocoon.

2. In the mulberry-fed worms there exists a very definite and constant relation between amount of food and size as indicated by weight, the starveling individuals being consistently smaller than the well-nourished, the lingering effects of this dwarfing being handed down even unto the third generation, although the progeny of the famine generation be fed the optimum amount of food; in case the diminished nourishment is imposed upon three or even two successive generations there is produced a diminutive, but still fertile, race of Lilliputian silkworms whose moths, as regards wing expanse, might join the ranks of the micro-Lepidoptera almost unremarked.

In illustration may be quoted the typical or modal larval weights for each of the lots of 1903 at the time of readiness to spin, which marks the completion of the feeding and is, therefore, an advantageous point for a summary of the results of the three years' experimental feeding.

The history of the eight lots referred to may be gathered from an examination of the accompanying table, in which 'O' means optimum amount of food and 'S' means short rations. The column to the right indicates the relative rank of the various lots as judged by the modes of frequency polygons erected to include all the individual weights for each lot at spinning time.

Lot Number.	History of Lots.			Modal Rank. 1903.
	1901. Grandparents.	1902. Parents.	1903.	
1	O	O	O	1
2	O	O	S	6
3	O	S	O	3
4	O	S	S	7
5	S	O	O	2
6	S	O	S	5
7	S	S	O	4
8	S	S	S	8

We find that control lot 1, consisting of normally fed individuals of normal ancestry, holds first rank in weight, as was to be expected. Second comes lot 5, whose grandparents experienced a famine but whose parents as well as themselves enjoyed years of plenty. Lots 2 and 3 have likewise had one ancestral generation on short rations, and the fact that they are lighter in weight than lot 5 illustrates a general rule which obtains throughout the entire company of experimental worms, namely, that the effects of famine grow less evident the further removed the individuals are from its occurrence in their ancestral history. Thus lot 5 is two generations removed from the famine of 1901, while lot 3 has had but one generation in which to recover its ancestral loss. Lot 2, which has had a total of but one famine year—the current year—nevertheless ranks

below lot 7, which has had two famine years in its ancestry succeeded by plenty during the current year. Lot 2 also ranks below lot 6, a fact which appears strange, considering that lot 6 has suffered two generation of famine, including the current year, which is the only famine year experienced by lot 2. In explanation of this anomalous condition it is suggested that possibly the larvæ of lot 6 were better fitted for enduring and making the best of hard conditions than were the individuals of lot 2, the ancestors of the former lot having been selected two years ago on a food-scarcity basis. This suggestion gathers support from an inspection of the mortality notes, from which it appears that the number of deaths —for which the famine was probably a contributing and not a primary cause—in each lot which is for the first time subjected to short rations is almost doubly greater than the number of deaths in lots which are descended from starved ancestors, whether these ancestral famines occurred in successive or alternate years. The figures indicate that a reduction of food is almost twice as destructive upon the first generation which is subjected to it as it is when visited on a second generation. Lot 4 follows lot 2 as the seventh in rank and its position is in accord with the rule above noted, its latest ancestral generation which enjoyed an optimum amount of food having been grandparental, whereas the ancestors of all the other lots except lot 8 have had the optimum amount of food during 1902 or 1903. Lot 8 holds lowest rank, it and its ancestors having been subject to trying conditions throughout the entire three years, during some one or two of which all the other lots have enjoyed the best of food conditions. Thus it appears that a generation of famine leaves its impression upon at least the three generations which succeed it, yet the power of recovery through generous feeding exhibited by the progeny of individuals subjected to famine is so extensive (witness lot 5) that it appears probable that every trace left by the famine upon the race would eventually disappear. It is even conceivable that the ultimate result of the famine would be a strengthening of the race, the famine having acted the part of a selective agent, preserving only the strong.

But although there is a large difference between the well-fed and the poorly fed, there persists, more obviously in late than in early life, a very considerable discrepancy as to size among the individuals of each single lot whose environment, in so far as food, temperature, room, humidity, etc., constitute it, is identical.

For example, referring again to the weights at spinning time of the larvæ of 1903, it is true that although each lot has a modal class of weights to which the majority of its individuals belong and about which the rest of the lot distributes itself rather symmetrically, the extremes are surprisingly distant from one another. Thus in lot 1 (the normal control lot) the extremes are 1,540 and 2,530 mg.; in lot 2,* 800 and 1,402 mg.; in lot 3, 1,180 and 2,170 mg.; in lot 4, 690 and 1,204 mg.; in lot 5, 1,370 and 2,100 mg.

That is to say, identical feeding has not made identical full-grown larvæ out of individuals which undoubtedly varied *congenitally* at the start, those variations—in embryo—standing at birth in the same relation to one another that they stand in the adults, having merely been *smaller* and less readily discernible in early life, although manifestly present in delicately measurable degree in the earliest records made upon normal individuals. For example, weight measurements taken immediately after the second moult range in one lot from 21 to 39 mg., or 60 per cent. of the modal weight, while the weights in this same lot at spinning time,

* See table, page 746, for the history of each lot.

some five weeks later, range from 534 to 2,080 mg., or 85 per cent. of the mode for the lot. These embryonic but potentially large variations have simply 'grown up' along with the insect and are as truly congenital in the adult as they were in the newly hatched larva. This would seem to place quite conclusively in the category of congenital variations some part of those variations (in size and proportions of parts) which are commonly, and properly to some degree, called acquired.

3. That conditions of alimentation bear a directive relation to functional activity may be demonstrated by reference to the records of the physiological functions of moulting, spinning, pupating and emerging, of the individuals of the experimental lots.

An abnormal extension of the time needed for the metamorphosis follows upon a reduction of the food supply. The degree of extension depends with the utmost nicety upon the amount of food given the larvæ. For example, among the 1901 generation of silkworms, one control lot of twenty larvæ was given the optimum amount of food, a second lot of twenty larvæ one half this amount, and a third lot of twenty larvæ one quarter of the amount. To take the time of the fourth moulting as an illustration, the moulting was begun by the first lot, which led the way by two and a half days, at the end of which the second lot began to moult, while the third lot was twenty-four hours behind the second. All the individuals of the first lot had finished moulting on April 20, all of the second on April 24, while the moulting in the third lot continued until April 29.

As in the matter of weight, this retarding of the functions, by means of a reduced food supply, affects not only the immediate generation which is subjected to the famine, but the lingering effects of it may be traced in the progeny of the dwarfed individuals at least unto the third generation, even though two years of plenty follow the one year of famine. The conditions which obtain in each lot of individuals of the 1903 generation at spinning time are shown in the accompanying table, which is based upon polygons erected to include all the individuals in each lot.

Lot Number.	History of Lots.			Rank of 1903 Lots as to Promptness in Spinning.			
	1901. Grandparents.	1902. Parents.	1903.	Earliest Spinner.	When Two-thirds of Each Lot were Spinning. Date.	When Two-thirds of Each Lot were Spinning. In Order of Rank.	Latest Spinner.
1	O	O	O	1	May 12	1	1
2	O	O	S	5	" 25	4	4
3	O	S	O	2	" 13	2	3
4	O	S	S	4	" 26	5	5
5	S	O	O	3	" 13	2	2
6	S	O	S	6	" 29	6	7
7	S	S	O	6	" 22	3	5
8	S	S	S	7	" 30	7	6

This period in the life of the silkworms is particularly advantageous for consideration here because it marks the completion of the feeding, so that the individuals of under-fed ancestry have been given the best chance to recover, while those subject to altered food conditions have had the benefit of the alteration during the entire food-taking period of life.

In the table 'O' means optimum amount of food and 'S' means short rations. To the right of the history of the lots is a section showing the rank of the lots as to the extreme time limits of the spinning

time (emphasized congenital differences again), with a safer criterion, as to their relative promptness, in the column between the extremes—a column of figures intended to show the relative promptness with which a two thirds majority of the larvæ in each lot arrives at the spinning time, this proportion being taken to represent the typical condition for the lot. The order in which the lots are arranged in this column corresponds in a general way with that prevalent for the weights at spinning time, and the generalizations indulged in there may with few exceptions be applied here. The lots which were well fed during the 1903 generation are ahead of all of those given short rations in 1903, whatever ancestry they may have had. Lot 1 leads here as in the matter of weight. Lots 3 and 5 tie for second place, having held second and third places in weight. Lots 2 and 4 stand in the same relation to one another that they held as to weight. Contrary to the weight relation, lot 6 follows lot 2 at the spinning—a fact which illustrates again the general rule that two generations of famine are more disastrous than one, but does not lend support to the notion of natural selection on a food scarcity basis, as previously suggested. Lot 8, which has had no relief from famine during the entire three years, brings up the rear at the spinning, as might be expected.

This check upon functional activity exercised by diminished nourishment affects the moulting, the time for the commencement of spinning and the issuing time for the adults, but the time spent in the spinning of the cocoon, from its beginnings in the threads of the supporting net to its apparent completion when the cocoon becomes opaque, is practically identical for under-fed and well-fed individuals. A reason for this exception to the tardy habits of the under-fed is to be found in the fact that the under-fed larvæ produce less silk (less in size, thickness and weight) than the well-fed, thus accomplishing more meager results in the same amount of time. That the individuals sentenced to short rations should produce less silk than their well-fed neighbors is certainly to be expected, silk not being made without leaves any more readily than bricks without straw.

4. Not only do short rations protract the time appointed for the spinning, moulting, etc., but they appear to have a more striking effect upon the actual occurrence of the moulting. The normal number of moults for the silkworm larva is four. Five moults have occurred for most of the individuals belonging to the under-fed lots of 1902 and 1903, whereas none of the well-fed individuals has undergone a fifth moult. It would seem, therefore, that the occurrence of a fifth moult may be fairly ascribed to a reduction of food; at least a fifth moult very frequently accompanies it and has suggested the possibility that the enforced fasting of the under-fed larva—in the intervals between meals—may have the same physiological effect as the normal fasting which precedes the normal moulting, during which time the so-called 'moulting fluid' is secreted. That this effect may accumulate throughout the lifetime of the larva until the larva is actually forced to indulge in the extravagance (of strength, feeding time and body wall material) of an additional moult is conceivable and will justify a further test.

5. As to the life and death selection due to famine, it may be said, in addition to the previous discussion of mortality among the experimental silkworms, that while lots subjected to two years of famine (themselves in one year, their parents in the year before) were fertile in so far as number of young hatched is concerned, it was found to be exceedingly difficult to rear from them a 1903 generation. Indeed, at the time of the second moulting there were but

nineteen individuals (and tolerably vigorous larvæ they were) alive in the lot which had experienced two years of famine, although every individual of the 149 hatched was carefully preserved and royally fed —a fact which goes to prove that the equipment at birth of many of these larvæ was inadequate.

The fact that some larvæ of starved ancestry have exhibited a superiority over their fellows, in surviving and recovering from hard conditions, is testimony for the existence of individual variations which can not be defined anatomically, and yet which serve as 'handles' for natural selective agents. Such variations might be called physiological variations, since it seems that the surviving larvæ must be those which are in best trim physiologically. These larvæ are able to make the most of the food offered to them. If competition were allowed, they would probably be the individuals which would cover the area most rapidly, securing whatever food there might be. But under our experimental conditions there was no competition allowed and yet certain precocious individuals made more grams of flesh and more yards of silk, than other larvæ furnished with the same amount of raw material under like conditions; that this was due to the possession by the former of certain congenital qualities of adaptability can scarcely be doubted.

6. As to the fertility of the variously fed lots; in so far as number of eggs produced is a measure of fertility, our records already demonstrate the fact that the better nourished are the more fertile. Furthermore, the economy in this matter practised by the starvelings is not merely numerical, quality as well as quantity of eggs being affected. In witness of this point may be recalled the story of the dying 1903 generation, produced from eggs of the starvelings of 1901 and 1902, which would seem to offer conclusive evidence that a famine suffered by the parents works its way into the germ cells so that most of their progeny have but a poor birthright.

A more exhaustive study of silkworm fertility and its correlation with anatomical variations and physiological vigor has been begun, and when it is carried to the point of indicating not only how many eggs are laid but how many eggs develop through larval and pupal stages into fertile adults, some clear light may be thrown upon such questions as that which arises concerning the precise ancestry of the survivors of our induced famine and the part these survivors will play in race history.

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SCIENTIFIC BOOKS.

RECENT PSYCHOLOGICAL LITERATURE.

The lack of an adequate history of the remarkable developments in psychology during the last quarter century has been keenly felt in many directions and not least by the psychologists themselves. The task of supplying this need is peculiarly difficult. For its successful accomplishment one must possess not only the rare gift of lucid and accurate exposition, but one must also be a competent philosophical scholar, with a considerable knowledge of biology in addition to a wide and exact acquaintance with the many phases of psychology itself. The fulfillment of these trying requirements has been in effect essayed by Guido Villa, of the University of Rome.* His book is not entitled a history, but in substance it is such, being an effort to give, in connection with comments upon the work of various authors, a correct impression of the general drift of contemporary psychology.

It must be admitted that the book is superior to anything else at the moment available. It represents an immense amount of patient en-

* 'Contemporary Psychology by Guido Villa' (translation by Harold Manacorda), Swan Sonnenschein & Co., London, 1903, pp. xv + 396.

deavor and it is marked throughout by an evident fairness of spirit, for all of which the writer deserves appreciation and credit. Moreover, it is, on the whole, clear, the author being at his best in dealing with the more philosophical aspects of his subject. The translator has done his work acceptably. Nevertheless the book suffers from several serious defects. Thus, for example, although much space is devoted to the description of Wundtian doctrine, the portrayal of the methods and results of experimental psychology is distinctly inadequate. No one could possibly gain from it a just conception of the scope and solidity of achievement of this branch of psychological work. Morbid psychology, animal psychology and the psychology of religion are even more gravely misevaluated. Needlessly distressing are the misprints which deface almost every page, distorting dates, rendering proper names in some cases almost unrecognizable, etc. An exasperatingly incomplete index furnishes the climax of this kind of annoyance.

Professor Royce has put aside his metaphysics long enough to write an admirable psychology, which is ostensibly constructed for teachers, but will undoubtedly find a much wider public.* Indeed, it will probably be only the better trained teachers who will successfully follow the text, for the author has written with something of his usual fullness and freedom, and the average pedagogue commonly demands his intellectual pabulum cut up in smaller pieces than those here offered. Several novel features appear in the construction of the book, which is extremely suggestive, and characterized throughout by a strong flavor of practical common sense.

In the first place, the author has abandoned the conventional lines of division of the psychological field into cognition, feeling and will. In their stead occur the categories of 'sensitiveness,' under which are included feeling and sensory discrimination: 'docility,' in connection with which we find discussions of the multifarious influences of past experience upon the consciousness of the present moment; and 'mental initiative,' under which we are confronted with those facts which indicate a factor of variation and individual peculiarity entering into our mental operations. These rubrics are in essence, perhaps, variants upon current usage rather than wholly original, but they undoubtedly serve to avoid certain perils to which the customary method of division is exposed and they facilitate the practical applications of a broadly pedagogical character which the author desires to make.

An entirely novel doctrine, so far as I am aware, is, however, advanced in connection with the theory of feeling. As is well known, pleasure and displeasure have long held sway as the sole rudimentary forms of feeling. Wundt has recently contended for two other elementary polar groups, *i. e.*, feelings of excitement and depression and feelings of tension and relief. Professor Royce proposes *two* fundamental groups, *i. e.*, pleasure and displeasure, restlessness and quiescence. Space does not permit an examination of the merits of this program. Suffice it to say, that the deficiencies of the pleasure-displeasure classification as usually advocated are increasingly evident, and in the reconstruction which appears to be immediately at hand Professor Royce's proposition may prove to be as near the mark as any. He seems to be unaware of the support afforded such a theory as his own by the physiological observations of Binet, Courtier, Vaschide, Thompson and the reviewer.

Another striking feature of the book is the attempt to connect the phenomena of mental initiative and variation with such organic reactions as those to which Loeb and others have given the name of tropisms. The point which our author wishes to make is the recognition of a type of spontaneity independent of the individual's own past experience and independent of the usual hereditary factors of the instinct variety. That the two groups of phenomena are analogous to one another hardly admits of doubt, but in identifying the two activities so closely Professor Royce has surely allowed his first enthusiasm to carry him

* 'Outlines of Psychology, An Elementary Treatise with Some Practical Applications,' by Josiah Royce, The Macmillan Company, New York, 1903, pp. xxvii + 392.

beyond the definite implication of the facts at present known. Save in the case of obviously morbid conditions there is never any such persistent adherence to impulses operating independent of, or counter to, the influence of the individual's past experience as that manifested by the true physiological tropisms. A genuine mental variation from type must be recognized and provided for in our psychology, but to do this it is neither necessary nor altogether permissible to invoke the tropism concept in an unmodified form.

Another agreeably written book for teachers comes from the hand of Dr. Judd.* It is practically a series of essays dealing with certain of the contact points between psychology and education. The keynote of the book is the principle of development through expression, which the author dwells upon in an illuminating way in its psychological and practical aspects. The elementary school problems centering about reading, writing and arithmetic are discussed in the light of this principle and a number of instructive and interesting experiments and observations are reported. The volume does not belong to an order of books in which startling originality is feasible, but it is informed throughout with admirable good sense; it is suggestive on specific concrete points and it is thoroughly intelligible to even the casual reader, so that it ought to be found a very useful addition to the resources of those for whom it has been prepared.

Experimental psychology has had its apologists and its popularizers. Professor Stratton is, however, the first to attempt on an extensive scale the exhibition of its bearings upon our general philosophical and intellectual interests. † His book, which is written in a forceful and attractive style, is addressed primarily to the intelligent and serious-minded person who cares to keep in touch with the scientific developments of his own day, especially the broader and more distinctly cultural implications of those developments. Experimental investigations (a number of them original) have been selected for discussion, which bear directly upon such problems as those of the existence of unconscious ideas, the nature and reality of personal identity, the character of time and space, the connection of mind and brain, etc. The exact procedure in typical psychological experiments is vividly described in connection with copious photographs and drawings, so that even the veriest tyro may obtain a correct impression of the technique in such work. The general treatment, although fresh, vigorous and independent in its temper, is conservative and trustworthy, following in the main the lines of commonly accepted theories. Although there may be some disappointment that the results gained from experiment do not speak with a tone of greater finality upon the philosophical problems to which they are applied, there can be no question that the author succeeds admirably in showing how they contribute their quota of novel and reliable evidence in favor of one or another of the possible solutions of such problems. By reason of its interesting collocation of material, not to mention its other excellencies, the book is likely to prove as valuable to psychologists as to those outside the strictly psychological pale.

Despite the independent status of psychology, it is still true that its logical bases as well as its history must always keep it close to philosophy. Especially is it true that now and again its fundamental presuppositions and assumptions must be examined and tested. No problem of this general character is more insistent than that of the relation between the mind and the body. Experimental psychologists have largely come to adopt the position of psychophysical parallelism as a tentative working basis, frankly recognizing its limitations and defects. In view of the utter instability of opinion manifested by the controversial literature of the subject, this practical attitude is not difficult to understand. Professor Strong has just rendered yeoman service by setting in order the various pros and cons

* 'Genetic Psychology for Teachers,' by Charles Hubbard Judd, D. Appleton & Co., New York, 1903, pp. xiii + 329.

† 'Experimental Psychology and its Bearing upon Culture,' by George Malcolm Stratton, The Macmillan Company, New York, 1903, pp. vii + 331.

upon the matter.* He brings wide knowledge, unbiased judgment and unusual critical acumen to his task, and the result is a work of marked distinction. The various contentions of automatism, parallelism and interactionism are successively examined, and after the expurgation of all fallacies, the residuum of uncontroverted doctrine is elaborated into the theory of psychophysical idealism—a theory closely akin to the panpsychism of Fechner, Clifford and others.

Psychophysical idealism inverts the materialistic view, in accordance with which the brain is the reality and consciousness a mere unsubstantial phenomenon, and maintains that the mind is the reality—the thing-in-itself—of which the brain is the phenomenal manifestation. This sounds at first like a very naïve form of subjective idealism, offensive to all persons of Dr. Johnson's persuasion and to many others less strenuous. And idealism it is, but by no means naive in the arguments upon which it is based, including, as these do, scholarly considerations of the nature of causation and the law of the conservation of energy, discussions of the pertinent facts in physiological psychology, etc. An adequate critical analysis of Professor Strong's theory is evidently out of the question at this time. It should not be forgotten, however, that theories of this type, while avoiding the crass incongruities of the common forms of materialism, the inconsistencies of interactionism and the inconclusiveness of parallelism, are nevertheless incessantly haunted by the ghost of solipsism. If the solipsistic position be accepted, it then requires a constant miracle, of the kind resorted to by occasionalism, to account for the orderliness of the physical cosmos upon which we are all so unanimously agreed. Whether Professor Strong has wholly avoided the treacherous solipsistic pitfalls, the reader must decide for himself.

JAMES ROWLAND ANGELL.

*'Why the Mind has a Body,' by C. A. Strong. The Macmillan Company, New York, 1903, pp. x + 355.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Comparative Neurology for October contains five papers, as follows: (1) 'The Neurofibrillar Structures in the Ganglia of the Leech and Crayfish, with Especial Reference to the Neurone Theory,' by C. W. Prentiss. Establishes fibrillar continuity between the nerve elements, confirming in this respect the conclusions of Bethe and Apáthy. (2) 'On the Increase in the Number of Medullated Nerve Fibers in the Ventral Roots of the Spinal Nerves of the Growing White Rat,' by Shinkishi Hatai. The total number of medullated fibers in the ventral roots of the adult is 2.7 times that of the rat ten days old, and at all ages the total number of medullated ventral root fibers decreases from the spinal cord toward the periphery. (3) 'On the Medullated Nerve Fibers crossing the Site of Lesions in the Brain of the White Rat,' by S. Walter Ranson. Operations on very young rats heal with no appreciable scar and the site of the lesions is crossed by medullated fibers. These are presumably entirely new axones, for the power of regeneration seems to be lost in the adult. (4) 'On the Density of the Cutaneous Innervation in Man,' by Charles E. Ingbert. About 79 per cent. of the medullated dorsal root fibers innervate the skin and 21 per cent. are afferent fibers from muscles and deep tissues. One cutaneous spinal nerve fiber innervates, taking the average of the entire body, 2.05 sq. mm. of the skin. (5) 'On a Law determining the Number of Medullated Nerve Fibers innervating the Thigh, Shank and Foot of the Frog—*Rana virescens*,' by Henry H. Donaldson. The nerve fibers entering the leg being considered as so many separate lines of connection with the several segments, are found to be distributed in accordance with the law that the efferent fibers are present in proportion to the weight of the muscle, and the afferent in proportion to the area of skin.

SOCIETIES AND ACADEMIES.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

THE American Association for the Advancement of Science, the American Society

of Naturalists and the following affiliated societies will meet at St. Louis, Mo., during the week beginning on December 28.

The American Association for the Advancement of Science. The week beginning on December 28, 1903. President, The Hon. Carroll D. Wright; Permanent Secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; General Secretary, Dr. Chas. W. Stiles, U. S. Department of Agriculture, Washington, D. C.; Secretary of the Council, President Chas. S. Howe, Case School of Applied Science, Cleveland, Ohio. *Local Executive Committee,* President, Professor William Trelease; Secretary, Alexander S. Langsdorf.

Section A—Mathematics and Astronomy. Vice-president, O. H. Tittmann; Secretary, Professor L. G. Weld, University of Iowa, Iowa City, Ia.

Section B—Physics. Vice-president, Professor Edwin H. Hall; Secretary, Professor D. C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C—Chemistry. Vice-president, Professor W. D. Bancroft; Secretary, Professor A. H. Gill, Massachusetts Institute of Technology, Boston, Mass.

Section D—Mechanical Science and Engineering. Vice-president, Professor C. M. Woodward; Secretary, Professor Wm. T. Magruder, Ohio State University.

Section E—Geology and Geography. Vice-president, Professor I. C. Russell; Secretary, Dr. G. B. Shattuck, The Johns Hopkins University, Baltimore, Md.

Section F—Zoology. Vice-president, Professor E. L. Mark; Secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G—Botany. Vice-president, Professor T. H. MacBride; Secretary, Professor F. E. Lloyd, Teachers College, Columbia University, New York City.

Section H—Anthropology. Vice-president, Professor M. H. Saville; Secretary, Dr. R. B. Dixon, Harvard University, Cambridge, Mass.

Section I—Social and Economic Science. Vice-president, Judge S. E. Baldwin; Secretary, J. E. Crowell, U. S. Department of Agriculture, Washington, D. C.

Section K—Physiology and Experimental Medicine. President, Professor H. P. Bowditch; Secretary, Professor F. S. Lee, Columbia University, New York. There will be no meeting of Section K at the St. Louis meeting.

The American Society of Naturalists. December 29 and 30. President, Professor William Trelease; Secretary, Dr. Ross G. Harrison, The Johns Hopkins University, Baltimore, Md. *The Central Branch* of the society meets at the same time and place. President, Professor John M. Coulter; Secretary, Professor W. J. Moenkhaus, Indiana University, Bloomington, Ind.

The Astronomical and Astrophysical Society of America. December 29, 30. President, Professor Simon Newcomb; Secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

American Physical Society. During convocation week. President, Arthur G. Webster; Secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society. December 28, 29. President, Professor John H. Long; Secretary, Professor W. A. Noyes, The Johns Hopkins University, Baltimore, Md.

The Geological Society of America. December 30, 31, 1903, January 1, 1904. President, Dr. S. F. Emmons; Secretary, Professor H. L. Fairchild, University of Rochester, Rochester, N. Y. *Cordilleran Section.* San Francisco. January 1, 2, 1904.

The American Mathematical Society—Chicago Section. Secretary, Professor Thomas F. Holgate, Northwestern University, Evanston, Ill. *San Francisco Section.* Berkeley, Cal. December 19. Secretary, Professor G. A. Miller, Stanford University, Cal.

Botanical Society of America. December 30, 31. President, B. T. Galloway; Secretary D. T. MacDougall, New York Botanical Garden, Bronx Park, N. Y.

The Central Botanists' Association. President, Conway MacMillan; Secretary, C. F. Millspaugh, Field Columbian Museum, Chicago, Ill.

The Botanical Club of the Association. Probably, at convenient times.

The Society for Horticultural Science. December 28, 29. President, Professor L. H. Bailey; Secretary, S. A. Beach, Geneva, N. Y.

The Fern Chapter. Time to be announced. President, B. D. Gilbert; Secretary, H. D. House, Botanical Garden, Bronx Park, New York, N. Y.

The Society for the Promotion of Agricultural Science. December 28, 29, 30, 31, 1903, January 1, 1904. President, Dr. William Frear; Secretary, Professor F. M. Webster, University of Illinois, Urbana, Ill.

American Society of Zoologists, Central Branch. December 29, 30, 31. President, Professor Jacob E. Reighard; Secretary, Professor Frank Smith, University of Illinois, Urbana, Ill.

The Association of Economic Entomologists. December 29, 30. President, Professor Mark V.

Slingerland; Secretary, Professor A. F. Burgess, Ohio State University, Columbus, Ohio.

The Entomological Club of the Association. At convenient times. President, E. A. Schwarz; Secretary, C. L. Marlatt, Department of Agriculture, Washington, D. C.

The American Microscopical Society. December 28, probably. President, T. J. Burrill; Secretary, H. B. Ward, Lincoln, Nebraska.

Association of Plant and Animal Breeders. First general meeting. December 29, 30. Chairman of Committee, W. M. Hayes, University Farm, St. Anthony Park, Minn.

The American Anthropological Association. December 28, 1903, January 1, 2, 1904. President, Dr. W J McGee; Secretary, George H. Pepper, American Museum of Natural History, Central Park, New York City.

The American Psychological Association. December 29, 30. President, Dr. W. L. Bryan; Secretary, Professor Livingston Farrand, Columbia University, New York City.

The Sigma Xi Honorary Scientific Society. During convocation week. President S. W. Williston; Secretary, Professor E. S. Crawley, University of Pennsylvania, Philadelphia, Pa.

The National Educational Association, Department Presidents. About January 1, 1903. President, John W. Cook; Secretary, Irwin Shepard, Winona, Minn.

There will meet at Philadelphia:

The Association of American Anatomists. December 29, 30, 31. President, Professor G. S. Huntington; Secretary, Professor G. Carl Huber, University of Michigan, Ann Arbor, Mich.

The Society for Plant Morphology and Physiology. December 29, 30, 31. President, Professor Roland Thaxter; Secretary, Professor W. F. Ganong, Smith College, Northampton, Mass.

The Society of American Bacteriologists. December 29, 30. President, Professor H. W. Conn; Secretary, Professor E. O. Jordan, University of Chicago, Chicago, Ill.

The American Physiological Society. December 29, 30. President, Professor R. H. Chittenden; Secretary, Professor F. S. Lee, Columbia University, New York City.

There will meet at Princeton:

The American Philosophical Society. December 29 and 30. President, Professor Josiah Royce; Secretary, Professor H. N. Gardiner, Smith College, Northampton, Mass.

There will meet in New York:

The American Mathematical Society. Columbia University. December 28 and 29. President, Professor Thomas S. Fiske; Secretary, Professor F. N. Cole, Columbia University, New York City.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of November 16, 1903, twenty-three persons present, Professor A. W. Greeley, of Washington University, presented a report on experiments on the nature of the contraction of muscle. These experiments were undertaken with the view of working out more fully the mechanism involved in the galvanotropic and chemotropic reactions of *Paramœcia* in acid and alkaline media, as described in Professor Greeley's report before the academy last spring. In the experiments on the contraction of muscle, it was found that when the medusa, *Gonionemus*, was exposed to the constant current, rhythmical contractions began always on the cathodal side when the medusa was immersed in normal sea water, but that the contractions began on the anodal side in acidulated sea water. Likewise, it was shown that acids induce a phase of contraction, and alkalis a phase of relaxation. It was suggested that these results may throw some light on the supposed electrical nature of muscle contraction, and that they offer additional evidence toward the conclusion that the charge carried by the protoplasmic particles depends on certain definite chemical conditions of the surrounding medium.

WILLIAM TRELEASE,
Recording Secretary.

AMERICAN CHEMICAL SOCIETY. NEW YORK SECTION.

AT the second meeting of the season held November 6, at the Chemists' Club, the following papers were presented:

Nitro-sulphuric Acid and Its Action on Organic Compounds, Part I.: C. W. VOLNEY.

Dr. Volney presented the results of both special experiment and long observation on the behavior of nitro-sulphuric acid in the production of nitro compounds and organic nitrates,

especially nitroglycerin and guncotton, and showed that the action of the sulphuric acid is not merely that of a dehydrating agent, to absorb the water formed by the reaction. It was held that the nitric acid is itself dehydrated and condensed, the action being represented by the equation

$$2HNO_3 + H_2SO_4 = O\left\langle\begin{matrix}NO_2\\NO_2\end{matrix}\right\rangle SO_4 + H_2O,$$

which would explain satisfactorily the formation of the organic nitrates. The author promised a continuation of this paper in which the reactions will be discussed in detail.

Meta-amino-benzonitril and Some of Its Derivatives: H. T. BEANS.

A brief account of the previously published methods of obtaining *m*-amino-benzonitril was given, and a method for its preparation by reduction of the nitronitril with stannous chloride in hydrochloric acid was described. The acyl-, benzoyl-, urea-, thiourea-, oxal- and succinyl- derivatives were prepared and their properties and decompositions studied. The compound was also found to give addition and condensation products with chloral which were described.

The Proteolytic Cleavage-products of Gelatine: P. A. LEVENE.

The object of this work was to compare the composition of the intermediate digestion products of proteids. Special attention was paid to the percentage of glycocol in gelatine, gelatoses and gelatine peptone. It was found that gelatoses contained in their molecule more glycocol, while the peptone contained less glycocol, than gelatine. In harmony with this is the observation that in the early stages of digestion, of the final nitrogenous decomposition products only ammonia can be demonstrated, while on prolonged treatment with proteolytic enzymes glycocol appears in quantities predominating over other crystalline products of digestion. Among these, besides glycocol, were found leucin, glutamic acid and phenylalanin.

A Device for the Accurate Reading of Burettes: W. E. CHAMBERLAIN.

Dr. Chamberlain discussed briefly the avoidance of parallax in reading and of the adhesion of drops to the walls, in the use of burettes.

H. C. SHERMAN,
Secretary.

TORREY BOTANICAL CLUB.

AT a meeting of the club held at the College of Pharmacy, November 10, 1903, at 8 P.M., the following program was presented:

Mrs. Cunningham, of California, a prominent organizer in that state of clubs for the preservation of wild flowers, was present and by request exhibited a large collection of water-color sketches of California wild flowers and spoke briefly of the best places and seasons for finding them.

The first regular paper was by Dr. Underwood on 'The Botanical Gardens of Jamaica.' He outlined the history and described the present condition of each of the four public gardens of Jamaica, illustrating his remarks with numerous photographs. The first garden established was at Bath in 1779. This is at the eastern end of the island, where the climate is hot and very humid. It was virtually abandoned many years ago, but a number of interesting trees are still standing. The location was not fully satisfactory, and in 1863 another garden was established at Castleton in the Wag Water Valley, twenty-five miles north of Kingston. This is now probably the finest and most interesting botanical garden in the West Indies. It contains a very notable collection of palms, said to include 180 species. In 1868 another garden was established at Cinchona on one of the spurs of the Blue Mountain range at an elevation of nearly 5,000 feet. It was intended to test the practicability of the growing of cinchona for its bark on a commercial scale, but many other trees and plants adapted to high altitudes in the tropics were planted, and for some years it was the headquarters for the botanical work of the island. Owing to its inaccessibility, still another garden was established in 1873 at the Hope plantation in the outskirts of Kingston on the south side of the island. This is now the headquarters for the botanical and agricultural departments of Jamaica, and

besides its features as a botanical garden proper it is used as a nursery for propagating economic plants for distribution to the planters of the island and as an agricultural experiment station for the investigation of various agricultural problems.

The second paper was by Dr. Howe, on 'The So-called Flowering of the Adirondack Lakes,' a phenomenon caused by the growth of one of the minute blue-green algæ, specimens of which were exhibited. The substance of this paper appeared in the October issue of *Torreya*.

Dr. Britton spoke of the recent discovery by Mrs. Goodrich, at Syracuse, of *Phacelia dubia*, a plant new to the New York state flora. This discovery extends the known range of the plant several hundred miles farther north.

On motion, the thanks of the club were voted to Mrs. Cunningham for her interesting exhibition of flower paintings.

F. S. Earle,
Secretary.

THE SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

The club held its first meeting of the academic year on October 5, President F. P. Turneaure in the chair. The paper of the evening was given by Professor Victor Goldschmidt, of Heidelberg University, on 'Recent Developments in Crystallography.' Professor Goldschmidt discussed his recent work on the etching figures formed on calcite crystals and on spheres of calcite when subjected to the dissolving action of acids.

Victor Lenher,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE CHEMISTRY OF SOILS AS RELATED TO CROP PRODUCTION.*

The following quotations will best define the scope of this bulletin of seventy-one pages, and the theses which it is intended to establish and maintain.

Page 7. "The investigations made by the Bureau of Soils during the last ten years have shown that the economic distribution of crops is dependent mainly upon the physical characters of soils, and upon climate."

Page 13. "Briefly stated, the results given in the following pages appear to show, contrary to opinions which have long been held, that there is no obvious relation between the chemical composition of a soil as determined by the methods of analysis used and the yield of crops; but that the chief factor determining the yield is the physical condition of the soil under suitable climatic conditions."

Page 63. "The exhaustive investigation of many types of soil by very accurate methods of analysis under many conditions of cultivation and cropping, in areas yielding large crops and in adjoining areas yielding small crops, has shown that there is no obvious relation between the amount of the several nutritive ingredients in the soil and in the yield of crops."

Page 64. "It appears farther that practically all soils contain sufficient plant food for good crop yield; that this supply will be indefinitely maintained, and that the actual yield of plants adapted to the soils depends mainly, under favorable climatic conditions, upon the cultural methods; a conclusion strictly in accord with the experience of good farm practice in all countries."

The bulletin contains extended tables showing the results of the analytical work, and at the end, a full description of the methods employed therein.

The above four paragraphs, taken respectively from the beginning and the latter part of the bulletin, summarize the conclusions to which, as it states, 'the Bureau of Soils has been forced.'

These conclusions are certainly startling, to say the least; and perhaps not the least remarkable is the concluding one, which hardly agrees with the impressions left upon the mind of most of those who have made themselves acquainted with the history of agriculture, and its past and present practice in the most advanced civilizations.

Were such statements to emanate from a private laboratory, on a mere personal responsibility, it would be likely to be passed

* Bureau of Soils Bulletin No. 22, 1903.

over and allowed to run its course. But when it emanates from the head of the Bureau of Soils in the United States Department of Agriculture, and is expressly and persistently given as the opinion of that bureau, it can not be thus passed over unchallenged.

The above quotation from page 7 of the bulletin practically prejudges, or begs, the main question at issue. To any one outside of the bureau the cogency of this statement is far from apparent, except in so far as it may mean what has long been known and recognized, and need not, therefore, have been shown anew by the bureau.

If we examine the experimental basis upon which all these assertions are made, we find it to be the assumption that the aqueous soil solution is the exclusive source through which plants derive their food; and the fact, assumed to be demonstrated by a newly devised method of analysis, that that solution is practically of the same composition in all soils, so far as the mainly important plant-food ingredients are concerned. Throughout the bulletin the determinations thus made are considered and mentioned as constituting an 'exhaustive investigation of many types of soils, by very accurate methods of analysis.'

It is not the intention of the present writer to question the accuracy of the analyses, such as they are. But it is notorious that there are a great many methods that may and have been used for the chemical analysis of soils, each susceptible of great analytical accuracy, but in many if not in most cases having no practical bearing upon the agricultural value of the soils analyzed. The method of ultimate silicate analysis is one; and it is generally conceded that the results so obtained have but a very remote bearing upon the practical value of a soil. The method of extraction with distilled water is another; it is the opposite extreme, and unlike the silicate analysis, can certainly not be considered 'exhaustive.'

Now the criterion usually applied to the relevancy of soil analyses is whether they will stand the test of agricultural practice. Judged by this test, both the ultimate analysis and that by distilled water are, equally, failures, according to Whitney's own testimony. But his conclusion is that since his method fails as a criterion of rich and poor soils, therefore the chemical composition of soils has no bearing upon crop production; and that, therefore, 'the chief factor determining the yield is the physical condition of the soil under suitable conditions.'

To this assertion 'non sequitur!' is the obvious first answer. But before discussing it, it seems proper to recall, as regards the personal standpoint of the present writer, that he was the first one to undertake systematic physical soil work in the United States, in the early sixties; and has steadily pursued it ever since, as his publications* show. He has always held, taught and written that the physical soil conditions are the first thing needful to be considered in the estimate of a soil's practical value, the chemical composition second; since faults in the latter can in most cases be much more readily remedied than faulty physical conditions. But that chemical composition is the chief determining factor of phytogeography in the humid region, and inferentially of crop production within the same, became his conviction in the prosecution of the agricultural survey of Mississippi; and hence he made it prominent in his work in that state. In the arid region, where moisture is the dominant factor, and soil composition much less varied, soil physics has received his chief attention. It can not, therefore, be truthfully said that the writer has not fully recognized the enormous importance of physical soil conditions, both in his teachings and his publications.

Eleven years ago it fell to his lot to controvert the hypothesis then put forth by Whitney, to the effect that fertilizers act, not by conveying nourishment to plants, but by modifying the physical texture of the soil.† The recent enunciation of the chief of the Bureau

* *Proc. A. A. A. S.*, 1872, 1873; *Amer. Jour. Sci.*, 1872, 1873, 1879; *Proc. Soc. Prom. Agr. Sci.*, 1882–1898; 'Wollny's Forsch.,' 1879–1896; *Centralblatt für Agriculturchemie*, 1886; *Agr. Sci.*, 1892; *Jour. Amer. Chem. Soc.*, 1894; U. S. Weather Bureau Bull. No. 3, 1892; *Ann. de la Sci. Agron.*, 1892; Calif. Agr. Expt. Sta. Reports and Bulletins, 1877–1903.

† *Agr. Sci.*, 1892, pp. 321, 566.

of Soils, while still maintaining the preferential claim for the physical properties of the soil, at least admits the importance of the functions of plant food; but claims that fertilization is unnecessary because the supply will be 'indefinitely maintained.' He in fact takes us back to the times of Jethro Tull and the Louis Weedon system of culture, which also presupposed the indefinite duration of productiveness; but signally failed to realize it when the test of even as much as twelve years came to be applied. How can Whitney reconcile this predicted indefinite productiveness with the actual facts well known to every farmer, good and bad, who has ever taken fresh land into cultivation, and when pricing it is perfectly aware that after a period ranging from three years, *e. g.*, on the long-leaf pine lands of Mississippi to thirty or more years in the black prairies, he must needs resort to fertilization if he wants a paying crop; while in the Yazoo clay lands and the alluvial soil of the Houma country, hardly a diminution of production has occurred even yet? If, indeed, the soil solution is of the same composition in all these lands, then the common-sense conclusion is, obviously, that if the soil solution is the sole vehicle of plant nourishment, it must be supplied more quickly and continuously in the 'rich' than in the 'poor' soils. Certainly, *considering that both rich and poor soils are represented in the entire gamut of physical texture,* it is impossible to conceive that such changes in texture as would be brought about by poor cultivation should not occur in both. Yet the rich soils—those shown by the despised chemical analysis with strong acids to contain abundance of plant food, continue to produce abundantly, while the poor lands 'give out.' Hence, admitting for argument's sake that the soil solutions are really of the same chemical composition, it is clearly not the physical texture alone, or chiefly, that can account for these differences.

Whitney states in this connection (p. 51) that I have 'called attention to an apparent exception to this rule (that production is sensibly proportionate to the water supply) in heavy adobe (heavy clay) and sandy lands in California, which bear equally good crops of wheat.' It happens that this 'exception' holds good throughout the somewhat extensive arid region of the United States; and my explanation is not only, or mainly, that the roots go deeper, but that in the arid region, sandy soils are as a rule quite as rich in plant food (again by chemical analysis of the rejected sort) as the clay soils. Hence the abundant and lasting production of the arid sandy lands (even drifting sands) when irrigated.

Whitney's argument that even the rich arid soils can not yield more than the maximum crops of the humid region can hardly be taken seriously.

It is a striking fact that in the entire bulletin only a single full soil analysis (*i. e.*, one made with strong acids) is quoted. There is a table giving the results of determinations of available plant food, determined by the official method, alongside of the distilled water extract; and it is apparent that the two differ widely. But there is no definite agreement among soil chemists as to the 'available' determinations, whether as to value or method; the matter is still in the tentative stage, and I wholly dissent from the 'official prescription.' The table in question proves nothing. But it would have been instructive, so long as Whitney wishes to disprove the value of soil analysis as usually made, to have at least some of the soil classes he adduces as proofs, analyzed by the usual methods; if only in order to show that these soil types—the Cecil clay, the Sassafras loam, Norfolk sand, etc., are really, as alleged by him, the same soils over the area assigned to them. How have these soils been identified in the mapping? We are informed (p. 8) that 'the classification of soils in the surveys made by this bureau is based mainly on physical differences, apparent to a trained observer.' It is apparent from the annual reports that the mineralogical and geological data which are elsewhere considered as essential to a definite characterization of a soil, and which certainly are to be counted among the physical characteristics, are in most cases wholly ignored. Instead, we have local names by the thousand, conveying no meaning whatever to those not acquainted with the localities; since nothing but a scantily inter-

preted physical analysis is ordinarily given. Even when the mineral composition of the soil is obvious, these meaningless local names are retained as against preexisting local or descriptive designations. Thus we have, *e. g.*, a 'Fresno sand' appearing also in the report on Orange and Monterey Counties, California—localities hundreds of miles apart. To the uninitiated only the physical analysis is offered as a mark of their identity by the trained observer. It seems a pity that that training should not have extended to calling that material a granitic sand, which would have rendered the designation intelligible all over the world, at the same time conveying important practical information in view of the well-known cultural characteristics and value of granitic soils. It is given out that these studies will be made later in the laboratory. But it may be seriously questioned whether it would not be better to cover less ground more thoroughly, and be content with less extended and hasty mapping. This superficial method of work naturally excites criticism, not only at home, but also abroad.*

Until some better proof of identity is shown we can not accept Whitney's conclusions based on the similarity of the soil solution with widely varying production on 'the same soil'; and his entire argument suffers seriously from the absence of any convincing proof that 'rich' soils do not supply plant food, even in aqueous solution, *more rapidly* than does 'poor' land.

But is the aqueous solution the only source of supply? Whitney rejects *in toto* the idea that anything but the carbonic acid secreted by the roots aids the solution of plant food; but his method of analysis practically ignores even this solvent, the use of which was suggested and actually carried out by David Dale Owen, and tried by myself, in the early fifties. I found it unsatisfactory and abandoned it; but it would seem to have been incumbent upon Whitney and his coworkers to introduce this inevitable agency into their soil extractions, if it was intended to represent natural conditions. This is a fundamental, not to say fatal, defect.

* *Biedermann's Centralblatt*, February, 1903, p. 143.

But there is still a wide difference of opinion in this matter of the acid root secretions, and the investigators quoted by Whitney have by no means settled the matter. Among others, Kossowitch,* when observing the fact that calcic bicarbonate leached from his vegetation pots, failed to establish the absence of other organic acids from the solution. The old etching experiments have not, to my mind, lost their force; and in my experience I find it difficult to overcome the evidence of litmus paper reproducing a faithful image of citrus roots (in the soil) filled with a .83 per cent. solution of citric acid.† If the *paper* can take up the acid from the root surface, surely the much stronger capillary action of the soil can do so, according to Cameron's experiment quoted on page 54.‡ But if so, *Whitney's entire argument based on watery soil solutions falls to the ground.*

Not the least remarkable part of the bulletin is that in which Whitney discusses the use and action of fertilizers. He does admit that 'there is no question that in certain cases, and in many cases, the application of commercial fertilizers is beneficial to the crop.' But he calmly brushes aside, as so many cobwebs, the enormously cumulative evidence of all the practical experience of three quarters of a century in the use of commercial fertilizers, as well as the carefully guarded culture experiments made during that time by numerous scientific workers; and announces the truism that climatic and seasonal conditions *may* neutralize the beneficial effects of any and all fertilizers used. This has been long and often said, experienced and foreseen; every one

* 'Ann. de la Sc. Agron.,' 2 ser., 1, 220, 1903.

† Report Calif. Expt. Sta. for 1895–6 and 1896–7, p. 181.

‡ "When a porous cell having deposited in it a semipermeable membrane through which water can pass freely, but through which salts and certain organic substances like sugar can not pass readily, is buried in a soil short of saturation, but yet in fair condition for plant growth, the soil will draw water from the cell against a calculated osmotic pressure in the cell of 36 atmospheres, or about 500 pounds per square inch."

knows that deficiency of moisture or heat, or imperfect cultivation, as well as the improper manner of application of fertilizers, may render them wholly ineffective. We have also long known that soluble fertilizers soon become insoluble (but not necessarily unavailable) in the soil, in a manner fairly well understood, and that hence they can not long influence the watery soil solution to which Whitney pins his faith. But since the same conditions influence the unfertilized soils to even a greater degree, manifestly because of the slower and less vigorous development of the plants, it is not easy to see what special corroboration Whitney's hypothesis can derive therefrom. He calmly discards, as having been made under 'abnormal conditions,' the elaborate and conclusive experiments made by the best observers in pot culture, in which the physical factors were so controlled as to eliminate them from the problem of the action of special fertilizers; and we are told that 'very little effect is obtained in field culture in attempts to increase the value of crops showing inferior growth, by the application of fertilizers.' A trip through the malodorous turnip fields of the Low Countries or of Switzerland in autumn would convince even the Bureau that the thrifty inhabitants know that when a fertilizer is made to reach the feeding roots its action is invariably most strikingly beneficial. That a top dressing of insoluble fertilizers on a growing crop can do but little good needs no discussion; and it is but too true that a great deal of the fertilizers used in the arid region remains wholly ineffective for a long time because of the deep range of the feeding roots and the shallow application of insoluble fertilizers.

In the classic water-culture experiments of Birner and Lucanus, quoted in the bulletin (p. 15), the well water was supplied continuously and in indefinite amounts. It is thus no wonder that the results were so good, for at no time was there a lack of plant food supply, nor would such changes as would injuriously affect the growth occur. But for these frequent renewals of the water the result would doubtless have been very different, if only as a consequence of changes in the *reaction* of the solution. It is singular that this important point is not even casually mentioned in the bulletin with respect to the soil solutions. The deleterious effects of soil acidity upon most culture plants, long known in general, has been well and thoroughly investigated by H. J. Wheeler.* Yet neither in the tables nor in the text of this bulletin do we find any evidence that this point has had any attention with respect to its possible bearings on the differences in production on what are held by the bureau to be identical soil areas. We are not informed whether the large amounts of lime present in some of these solutions were sulphate or carbonate; yet the importance of this difference is enormous, as is well shown by the contrast between the natural vegetation as well as the cultural value of gypseous as against limestone lands, which are everywhere among the most productive. An excellent illustration of what this omission may mean exists on the Gulf Coast of Mississippi, where (as I have shown in the 'Report on Cotton Culture,' Tenth Census, Vol. 5, p. 69) the soil of the infertile 'sand hammocks' differs from the highly and lastingly productive soil of the 'shell hammocks' almost alone in the proportion of lime (calcic carbonate) and phosphoric acid present, and in having an acid reaction; the percentages of plant food being very low in both, and both equally of great depth. This observation, together with others, led me very early (1860) to the conclusion that mere *percentages* of plant food were not in all cases proper criteria of soil fertility; and also to the enunciation of the statement which I have repeated many times in both my teaching and my publications, to wit: 'While all fresh soils of high plant food percentages are highly productive under all but very extreme physical conditions, the reverse is by no means true; since soils with low percentages may be highly productive if the relative proportions of the several ingredients be good, and the soil mass deep.' I have for some years carried on an investigation to determine the limits of dilution within which plants will do equally well in soils of high fertility (and plant food percentages) when these are diluted

* Reports of the Rhode Island Expt. Sta.

with quartz sand. While not yet completed, this investigation has already shown that a rich adobe (clay) soil, as well as an equally rich sandy soil, diluted to an extent of four to one, shows equally good growth, but that when in these soils the dilution reaches five to one, development is quite slow, and in a short season would mean a crop failure. The moisture content was in all these cases maintained at one half the maximum water capacity of each diluted soil. Photographs show clearly that here the roots made up by their extension for the lack of concentration of the food supply; but at the dilution of one to five they were unable to make up that deficiency, at least within a reasonable time, although the same total *amount* of food ingredients was always present in the increased bulk. Other things being equal, it is the *proportion,* then, between the several soil ingredients, quite as much as the absolute quantity at hand, that determines production. Incidentally, this experiment shows the wide variation of physical composition (from a soil containing 35 per cent. of colloidal clay to one with only 8.75 per cent., and in the sandy soil from 7.6 per cent. to 1.9 per cent.) within which plants will do equally well, provided the plant food ingredients are rightly proportioned; and provided also that a proportionally large soil mass is available to each plant.

In the foregoing discussion, only the salient points of the bulletin in question have been taken up, and their most obvious weaknesses briefly considered. To do more would involve the writing of a paper as long as the bulletin itself; and it is to be hoped that the matter will be taken up by others, also. Thus, for instance, the Rothamstead Station might have something to say regarding the singular interpretation here put upon the splendid work of Lawes and Gilbert.

In conclusion, it seems to the writer that the verdict upon the main theses put forward so confidently in this paper must be an emphatic 'Not proven!'

E. W. Hilgard.

Berkeley, California,
November 11, 1903.

ABSORBED GASES AND VULCANISM.

To the Editor of Science: The descriptions of the spine of Mont Pelé by Hovey and Heilprin remind me of the phenomenon I observed some ten years ago, when my mind was on the subject of the part which the original absorbed gases play in vulcanism, as discussed in my paper in the *Bulletin of the Geol. Soc. Am.,* March 3, 1894. I had a bottle of Werner's grape milk packed in the place of the tin of an ice cream freezer, the same having served its purpose, in order to cool it. I presume any other carbonated beverage would work similarly. Though chilled well below 0° C. the beverage remained clear and unfrozen, as long as it was corked, but upon removing the cork the gas began to escape and freezing to set in rapidly. Sometimes nearly the whole contents of the bottle would freeze. Upon one occasion, however, I remember seeing a 'volcanic plug' of frozen matter forced out in a round cylinder from the neck.

I am inclined to think that there may be a very close analogy with the Mont Pelé spine. I think it would not be very difficult to reproduce this phenomenon, though I can not tell the exact temperature at which it occurred.

Alfred C. Lane.

SHORTER ARTICLES.

THE HEREDITY OF 'ANGORA' COAT IN MAMMALS.

That Mendel's law is a fundamental principle of heredity becomes daily clearer as new illustrations of its workings come to light, either through a reexamination of the older observations on heredity or through the performance of new experiments. One of these new illustrations it is the purpose of this note briefly to describe.

The writer has already pointed out, in the columns of Science, two pairs of alternative, or Mendelian, characters pertaining to the hairy coat of guinea-pigs. (1) A pigmented coat of any sort is dominant over an unpigmented, or albino, coat. Accordingly when a pure-bred pigmented guinea-pig is mated to an albino, the young are invariably pigmented. (2) The rough, or 'rosetted,' condition of coat found in so-called Abyssinian and Peru-

vian guinea-pigs is dominant over the normal, or smooth-coated, condition.

To these two pairs of Mendelian characters we may now add a third: 'Angora,' or long coat, is recessive with respect to the normal short coat. This fact was first discovered accidentally when a number of long-haired young were obtained by inbreeding a stock of short-haired guinea-pigs supposedly pure. A parallel result was obtained in the case of rabbits. Two rabbits, brother and sister, whose ancestors for at least two generations were known to have been short-haired, produced, in a litter of six young, two long-haired, or 'Angora,' individuals.

As a result of experiments subsequently made, it may now be said that, in the case of guinea-pigs and rabbits (and probably in other mammals also):

(1) Two long-haired animals of whatever ancestry produce only long-haired young; (2) a short-haired animal of pure stock, mated to a long-haired animal, produces offspring all short-haired; (3) a short-haired animal, one of whose parents was long-haired, when mated to a long-haired animal produces offspring, some short-haired, others long-haired, the two sorts occurring in approximately equal numbers; (4) two hybrid short-haired animals (like the one described under 3) when mated to each other produce long-haired and short-haired offspring approximately in the ratio, 1:3. These various facts agree in showing that short coat is 'dominant' in heredity over long or Angora coat.

The writer recalls seeing in the daily press some months ago a brief despatch (which unfortunately he did not preserve) recording the exportation (to Hagenbeck, he thinks) of the 'last of the Oregon Wonder horses,' which had mane and tail fourteen feet long. A short account, which was given, of the ancestry of this abnormally long-haired horse suggested to the writer that the long-haired character was in this case, as in rabbits and guinea-pigs, inherited as a recessive, and that the so-called 'last' of the long-haired horses need not have been such had the owner been familiar with the scientific principles of breeding. If any reader of Science can give further information about these long-haired Oregon horses, the writer would be very grateful to receive it. It seems to him extremely probable that in mammals in general an abnormally long coat behaves as a recessive character in heredity, when brought by cross-breeding into competition with the normal coat character. If so, this fact makes clear some matters which have been hitherto obscure and which have received a different but hardly satisfactory explanation. Thus Darwin attributes to the direct influence of the climate the long-haired coat character of the goats, shepherd-dogs and cats of Angora, and states on authority that the Karakool breed of sheep lose their peculiar fine, curled fleece when removed from their native canton near Bokhara. It is clear that a long-haired breed of animals would apparently lose that character completely and immediately, if allowed to cross with other breeds, as would likely be the case upon removal to a new locality. Yet this loss would occur irrespective of any climatic influence.

It is hoped that the facts here communicated may prove of some value to breeders of sheep and goats, such as are kept primarily for the fleece, as well as to breeders of pet stock. May we not work more intelligently for the improvement of our flocks, knowing the conditions under which the long-haired coat is transmitted?

W. E. Castle.
Zoological Laboratory,
Harvard University,
November 23, 1903.

CONCERNING MOSQUITO MIGRATIONS.

In the pages of Science I have recorded from time to time the results of my observations upon the habits of the ring-legged salt marsh mosquito, *Culex sollicitans*, and have expressed my conviction that it was a migratory form; limited in its breeding areas, but widely distributed and dominant for long distances away from them. In my study of the problem as it exists in New Jersey, this migration question is of the utmost importance, since local work can never be entirely effective if the mosquito supply comes from a place beyond the range of local jurisdiction. It is

absolutely necessary that the point should be positively determined, since no comprehensive plan can be formulated without considering how such migratory forms should be dealt with and what authority should have control.

During the season of 1902 I worked out the life cycle of *Culex sollicitans,* and satisfied myself that it was a true migrant. I found associated with it three other species, breeding under similar conditions, whose status I could not altogether fix. These were *C. nigritulus, C. tæniorhynchus* and one which I made certain was different from described species; but which was then determined by authorities to be a form of *C. sylvestris.* Further study proved my contention as to this species to be correct, and it has been recently named *C. cantator* by Mr. Coquillett. All these breed on the salt marshes and, as a rule, on the marshes only, though the water may be salt or fresh. *C. nigritulus* I have never found far away from the edge of the marsh in the adult condition. *C. tæniorhynchus* never flies very far nor in any considerable numbers. *C. cantator* and *sollicitans* have equal powers of flight and either may be dominant on the marsh at a given period, or both may be equally abundant.

Investigations made in 1903 indicate that *C. cantator* gets an earlier start and may fly long before *sollicitans* appears in large broods. Further, it is more northern in its range and, while it equals or exceeds *sollicitans* on the Raritan and Newark marshes, it is hardly noticeable from Barnegat Bay southward.

C. cantator is a stout, hairy yellowish-brown mosquito with obscurely banded legs; very different from the bright contrasts found in *sollicitans.*

To determine the question of migration and breeding areas positively, one observer was located at Cape May from the beginning of June to the end of September, with instructions to watch *C. sollicitans* day by day and, if it bred anywhere on the peninsula, to find the breeding places. Mr. Henry L. Viereck, who made these observations, reports positively that, while the adult occurred throughout the territory assigned to him, it bred only on the salt marshes or at their edge. Furthermore, he observed directly that, shortly after a brood emerged on the marshes, there would come a sudden decrease in the numbers of adults and a corresponding increase at points inland. In all his collectings not a *sollicitans* larva was found in the fresh-water swamp area of the peninsula!

Six other collectors were regularly in the field during the breeding season—not intermittently, but daily, and the result was that thirty-three species of mosquitoes were collected. And of these, thirty-one were actually bred from larvæ during the summer! Much of this collecting was done in the regions dominated by *sollicitans* and *cantator,* yet neither was found at any time in the larval stage away from the salt marshes or their edge.

Personally I watched the emergence of an early brood of *cantator* on the Newark meadows before there was a mosquito in the city, and when the surroundings on the hillside had been thoroughly surveyed and no similar larvæ discovered. These adults were watched from day to day as they spread inland until the city swarmed with them and they invaded the surrounding country in every direction. *C. sollicitans* did not at any time in 1903 dominate the Newark meadows as it did in 1902, and *cantator* was not generally recognized at first as a salt-marsh species.

At the mouth of the Raritan River the marshes near Perth and South Amboy were kept under close observation throughout June, and toward the end of that month conditions favored the development of an immense brood of mixed *sollicitans, cantator* and *tæniorhynchus.* Meanwhile the course of the Raritan had been followed up to Bound Brook and the territory around New Brunswick and Metuchen had been explored for miles without finding similar larvæ. July 1, the Amboy meadows were alive with adults, and during the night of July 2 to 3 the advance guard reached New Brunswick. The main body came during the two or three next following nights and extended up the Raritan valley. Another body followed a depression toward Metuchen and concentrated on Dunellen, where no chance for breeding such mosquito hordes exists.

Culex sollicitans is always the summer pest in the Jersey Pines—even where there is no water of any kind, and yet I had never been able to find in the swamps any larvæ. Mr. J. Turner Brakeley, who had made observations for me in previous years, began, early in this year, a systematic search in all the breeding areas near his cranberry bogs at Lahaway, over twenty miles in a direct line from the shore and nearly forty miles from the Mullica River marshes. He worked out the early life history of *Culex canadensis,* the winter history of *Culex melanurus* and discovered an entirely new species, *Culex aurifer;* but he failed absolutely to find any larvæ of *Culex sollicitans.* Nor did he see even the adults of that species until late in July; up to which time the pines were practically mosquito-free.

Dr. Julius Nelson, biologist to the New Jersey experiment stations, was engaged in oyster investigations on the marshes near Tuckerton during July and, incidentally, kept an eye on mosquito conditions for my benefit. Up to about July 12 the marshes were quite free from both adults and larvæ; but on that date an unusually high tide covered them and, on the 13th, minute wrigglers of *C. sollicitans* were in every water-filled hole. July 21 the males emerged in clouds and only pupæ were in the water. Females were out on the 22d but would not bite. On the evening of the 23d it was warm, with only a light breeze, and just at dusk a peculiar humming noise seemed to fill the air. The source of this was located at a height of between sixteen and twenty feet above the marsh, where clouds of mosquitoes hovered in their marriage flight. On the 24th few males were seen; but the females were now in droves and bloodthirsty as butchers. Then came cold north and west winds that kept the insects low down among the grass. On the 28th the wind veered to the south and continued so all that night and all day on the 29th. On the morning of the 29th the number of mosquitoes on the marsh had diminished materially, and this was yet more decidedly marked on the morning of the 30th when they were quite bearable. But in the woods, where on the 20th there had been few mosquitoes, they were worse on the 31st, when Dr. Nelson came out to Tuckerton, than they were on the marsh itself.

Dr. Nelson gave me this record on his return to New Brunswick and next morning came a letter from Mr. Brakeley who in previous communications had uniformly reported 'no salts.' Now, however, he sent in great detail, accompanied by specimens as vouchers, a report of how, during the night of July 28–29, *Culex sollicitans* had arrived in swarms and how, during the two nights following, the entire pine region for several miles round about had become infested. Of the testimony gathered by Mr. Brakeley one item is especially important—a farmer driving out for a doctor early in the evening through a mosquito-free wood and coming back late to find it swarming with bloodthirsty specimens.

Lahaway is exactly in the line of a flight on a south wind from the Mullica River, the distance to be covered is between thirty and forty miles, and the two series of entirely independent observations are altogether too closely congruent to be set aside as accidental and unconnected. The known antecedent conditions and the completeness of the observations leave only one possible explanation. The mosquitoes that left the marshes on the evening of July 28 reached the pines, over thirty miles north, before daylight next morning. What I have given here are examples of the kind of evidence that I have accumulated. It is not a series of isolated observations, but a daily record; made not by one man, but by a number working independently. Nor was the record confined to one period; it extended throughout the summer, beginning with the first larvæ found on the marshes in March and ending only with the last stragglers late in October.

It is of some importance to note that local conditions determine the development of these salt-marsh mosquitoes. All the species (save possibly *nigritulus*) lay their eggs in the mud of the marsh—never in water. Whenever these eggs become covered with water they hatch, and if there is water enough a brood develops. It may rain at Cape May and not at Atlantic City, and there has been a fall of

two inches or more at Newark, when not a drop fell on the Amboy marshes. There is no such thing, therefore, as a uniform breeding throughout the state, though identical conditions, like a general storm, may bring out broods from a number of localities at one time.

Nor is it impossible that, exceptionally, larvæ of any of the salt-marsh forms may be found away from their normal breeding areas. Personally I have never found *sollicitans* in that way; nor have any of my collectors so found it. But larvæ of *cantator* have been found on one occasion half a mile back, though not much above the general marsh level. But these are accidentals, due probably to the desire of a single gravid and perhaps injured female to place her supply of eggs.

John B. Smith.

Rutgers College, New Brunswick, N. J.,
November 25, 1903.

THE CONGRESS OF ARTS AND SCIENCE OF THE ST. LOUIS EXPOSITION.

As has already been stated here, the scientific committee of the St. Louis Exposition, consisting of Dr. Simon Newcomb, of Washington, Professor Hugo Münsterberg, of Harvard, and Professor Albion W. Small, of Chicago, visited Europe during the summer months to present personal invitations to European men of science to take part in the congress. The field was divided so that Dr. Newcomb gave his time to France and England, Professor Münsterberg to Germany and Switzerland and Professor Small to Austria and Russia, and in conjunction with Dr. Newcomb, to England. The committee returned to this country the latter part of September and reported to the Director of Congresses and the Administrative Board in New York, October 13. One hundred and fifteen acceptances have been received, as follows:

DEPARTMENT 1. PHILOSOPHY.

Metaphysics: Bergson, M. Henri, Membre de l'Institut, Paris.

Philosophy of Religion: Pfleiderer, Prof. Otto, The University, Berlin.

Logic: Riehl, Prof. Alois, The University, Halle. Windelband, Prof. Wilhelm, The University, Heidelberg.

Methodology: Ostwald, Prof. Wilhelm, The University, Leipzig. Erdmann, Prof. Benno, The University, Bonn.

Ethics: Sorley, Prof. W. R., The University, Cambridge, Eng.

Philosophy of Law: Binding, Prof. Karl, The University, Leipzig.

Esthetics: Lipps, Prof. Theodor, The University, Munich. Dessoir, Prof. Max, The University, Berlin.

DEPARTMENT 2. MATHEMATICS.

Geometry: Darboux, M. G., Membre de l'Institut, Paris.

Applied Mathematics: Boltzmann, Prof. Ludwig, Leipzig. Poincaré, M. H., Membre de l'Institut, Professor à la Sorbonne, Paris.

DEPARTMENT 3. POLITICS.

History of Asia: Cordier, M. Henri, Paris. Vämbéry, Prof. Armin, The University, Buda-Pest.

History of Greece and Rome: Pais, Signor Ettore, Musée Archeologique, Naples. Mahaffy, Prof. J. P., The University, Dublin.

Medieval History of Europe: Lamprecht, Prof. Karl, The University, Leipzig.

Modern History of Europe: Rambaud, M. A. N., Membre de l'Institut, Paris. Bury, J. B., Cambridge.

DEPARTMENT 4. LAW.

History of Roman Law: Zitelmann, Prof. Ernst, The University, Bonn.

DEPARTMENT 5. ECONOMICS.

History of Economic Institutions: Schmoller, Prof. Gustav, The University, Berlin.

DEPARTMENT 6. LANGUAGES.

Comparative Language: Brugmann, Prof. Friedrich Karl, The University, Leipzig. Paul, Prof. Hermann, The University, Munich.

Semitic Languages: Delitzsch, Professor Friedrich, The University, Berlin.

Indo-Iranian Language: Lévi, Prof Sylvain, Collège de France, Paris. Macdonnell, Prof. Arthur A., The University, Oxford.

Latin: Sonnenschein, Prof. E. A., The University, Birmingham.

English: Napier, Prof. Arthur Sampson, The University, Oxford.

Germanic: Sievers, Prof. Eduard, The University, Leipzig. Kluge, Prof. Friedrich, The University, Freiburg.

DEPARTMENT 7. LITERATURE.

Classical Literature: Jebb, Prof. Sir Richard C., The University, Cambridge, England.

Romantic Literature: Rajna, Prof. Pio, Florence.

Germanic Literature: Muncker, Prof. Franz, The University, Munich.

English Literature: Dowden, Prof. Edward, The University, Dublin.

Belles-Lettres: Brunetière, Marie-Ferdinand, Membre de l'Institut, Paris.

DEPARTMENT 8. EDUCATION.

History of Education and Educational Theory: Ziegler, Prof. Theobald, The University, Strassburg.

DEPARTMENT 9. ART.

Classical Archeology: Furthwängler, Prof. Adolf, The University, Munich.

History of Modern Architecture: Enlart M. Camille, Professor Écoles des Beaux Arts, Paris.

History of Modern Painting and Sculpture: Muther, Prof. Richard, The University, Breslau. Michel, M. André, Conservateur au Louvre, Paris.

DEPARTMENT 10. RELIGION.

Buddhism and Brahminism: Oldenberg, Prof. Hermann, The University, Kiel.

Mohammedanism: Ignácz, Prof. Goldziher, The University, Buda-Pest.

Old Testament: Smith, Rev. Prof. G. A., Glasgow, Scotland. Budde, Prof. Karl, The University, Marburg.

History of the Christian Church: Harnack, Prof. Adolf, The University, Berlin.

DEPARTMENT 11. PHYSICS.

Physics of Ether: Dewar, Prof. James, F.R.S., Royal Institution, London.

Physics of the Electron: Becquerel, M. Henri, Membre de l'Institut, Paris.

DEPARTMENT 12. CHEMISTRY.

Inorganic Chemistry: Mendeleef, Dmitry Iwanowitch, St. Petersburg.

Organic Chemistry: Fittig, Prof. Rudolf, The University, Strassburg.

Physical Chemistry: van't Hoff, Jakob Heinrich, Berlin.

Physiological Chemistry: Kossel, Prof. Albrecht, The University, Heidelberg.

DEPARTMENT 13. ASTRONOMY.

Astronomy: Backlund, Herr Otto, Director der Sternwarte, Pulkowa, Russia. Turner, Prof. H. H., F.R.S., Oxford.

Astro-Physics: Kapteyn, Prof. J. C., Groningen, Holland.

DEPARTMENT 14. SCIENCES OF THE EARTH.

Geology: Geikie, Sir Archibald, K.C.B., F.R.S., London.

Geo-Physics: Wiechert, Prof. Emil, Director Geo-Physikalischen Institut, Göttingen.

Geography: Mill, Dr. H. R., Librarian Royal Geographical Society, London. Gerland, Prof. Georg, The University, Strassburg.

Paleontology: Woodward, A. Smith, British Museum, London.

DEPARTMENT 15. PHYLOGENETIC BIOLOGY.

Plant Morphology: Bower, F. O., Glasgow. Goebel, Prof. K. F., The University, Munich.

Plant Physiology: Bonnier, Prof. Gaston, Paris.

Ecology: Flahault, Prof. Charles, The University, Montpelier. Drude, Prof. Oskar, Technische Hochschule, Dresden. Nuttall, G. H. F., Cambridge.

Animal Morphology: Girard, M. A. M., Membre de l'Institut, Paris.

Embryology: Hertwig, Oskar, The University, Berlin.

Comparative Anatomy: Delage, M. Yves, Membre de l'Institut, Paris. Fürbringer, Prof. Max, Heidelberg.

Human Anatomy: Waldeyer, Prof. Wilhelm, The University, Berlin.

Physiology: Engelmann, Prof. Theodor Wilhelm, Berlin.

Neurology: Erb, Prof. Wilhelm, The University, Heidelberg.

Pathology: Marchand, Felix, The University, Leipzig. Orth, Johannes, The University, Berlin.

Physical Anthropology: Manouvrier, M. L. Dodeur, Paris.

DEPARTMENT 16. PSYCHOLOGY.

Experimental Psychology: Ebbinghaus, Prof. Hermann, The University, Breslau.

Comparative and Genetic Psychology: Morgan, C. Lloyd, Univ. College, Bristol, Eng.

Abnormal Psychology: Janet, M. Pierre, Professor à la Sorbonne, Paris.

DEPARTMENT 17. SOCIOLOGY.

Ethnology: Steinen, Karl von den, The University, Berlin. Haddon, A. C., Christ's College, Cambridge.

Social Structure: Tönnies, Ferdinand, The University, Kiel. Ratzenhofer, Prof., Vienna.

Social Psychology: Simmel, Georg, Berlin.

DEPARTMENT 18. MEDICAL SCIENCE.

Internal Medicine: Allbutt, T. Clifford, Cambridge.

Gynecology: Richelot, Paris.

Otology and Laryngology: Seamon, Sir Felix, M.D., London.

Therapeutics: Brunton, Sir Lauder, K.C.B., F.R.S., London.

Tropical Medicine: Ross, Major F. W., The University College, Liverpool.

Pediatrics: Escherisch, Prof. Theodor, Vienna.

DEPARTMENT 19. TECHNOLOGY.

Mechanical Engineering: Riedler, A., Königliche Technische Hochschule, Berlin. Unwin, Prof. W. C., Central Technical College, London.

Chemical Technology: Witt, Otto N., Charlottenberg Polytechnic Institute, Berlin.

Agriculture: Lindet, Prof. Charles, Institute National Agronomique, Paris.

DEPARTMENT 20. PRACTICAL ECONOMICS.

Transportation: Philippovich, Eugen von, The University, Vienna.

Commerce and Exchange: Stieda, Wilhelm, Leipzig.

Money and Banking, Credit and Credit System: Lévy, Prof. Raphael Georges, Paris.

Industrial Organization: Conrad, Johannes-Ernst, The University, Halle.

DEPARTMENT 21. PRACTICAL POLITICS.

Diplomacy: Casimir-Perier, Ex-President.

National Administration: Bryce, Rt. Hon. James, 54 Portland Place, London.

Municipal Administration: Nerinck, A., University of Louvain.

DEPARTMENT 22. JURISPRUDENCE.

International Law: Zorn Philipp, The University, Bonn. Baron d'Estournelles de Constant, Paris.

Constitutional Law: Jellineck, Prof. Georg, The University, Heidelberg.

Criminal Law: Listz, Prof. Franz von, The University, Berlin. Wach, Prof. Adolf, The University, Leipzig.

Private Law: von Bar, Ludwig, Göttingen. Hilty, Prof. Karl, Berne.

DEPARTMENT 23. PRACTICAL SOCIAL SCIENCES.

The Rural Community: Weber, Prof. Max, The University, Heidelberg.

The Urban Community: Wuarin, Prof. Louis, The University, Geneva.

The Industrial Group: Sombart, Prof. Werner, The University, Breslau.

The Dependent Group: Münsterberg, E., Berlin.

The Criminal Group: Lombroso, Prof. Cesare, The University of Turin, Italy.

DEPARTMENT 24. PRACTICAL EDUCATION.

The School: Sadler, Prof. M. E., London.

The University: Ziegler, Prof. Theobald, The University, Strassburg.

The Library: Axon, Ernest, Assistant Librarian, Ref. Library, Manchester.

DEPARTMENT 25. PRACTICAL RELIGION.

Influence of Religion on Civilization: Black, Hugh, Edinburgh.

THE AMERICAN SOCIETY OF NATURALISTS.

The twenty-second annual meeting of the American Society of Naturalists will be held at St. Louis on December 29 and 30, in affiliation with the American Association for the Advancement of Science, under the presidency of Professor William Trelease, of the Missouri Botanical Garden. Headquarters will be at the Planters Hotel and the meetings will be held at the Central High School. The annual discussion will take place on the afternoon of December 30, on 'What academic degrees should be given for scientific work?' in which a number of prominent educators and naturalists will take part. The public lecture by President David Starr Jordan, of Stanford University, on 'The Resources of our Seas,' will be on Tuesday evening in the auditorium of the Central High School. The annual dinner and the president's address will be given on Wednesday evening, December 30, at seven o'clock at the Mercantile Club (7th and Locust Sts.). A business meeting for the election of officers will he held at 6:45. The societies affiliated with the American Society of Naturalists which will meet at St. Louis are The Zoologists of the Central States, The Botanists of the Central States, The American Psychological Association, The American Society of Anthropologists. The general Secretary is Professor G. Ross Harrison, The Johns Hopkins University, to whom communications should be addressed.

SCIENTIFIC NOTES AND NEWS.

The following is the list of council and officers of the Royal Society nominated by

the council for election by the society at the next anniversary: President, Sir William Huggins, K.C.B., O.M., D.C.L., LL.D.; treasurer, Alfred Bray Kempe, M.A.; secretaries, Professor Joseph Larmor, D.Sc., D.C.L., LL.D., Sir Archibald Geikie, Kt., D.C.L., Sc.D., LL.D.; foreign secretary, Francis Darwin, M.A., M.B. Other members of the council—George Albert Boulenger, F.Z.S., Professor John Rose Bradford, M.D., D.Sc., Professor Hugh Longbourne Callendar, LL.D., Frank Watson Dyson, M.A., Professor Harold Baily Dixon, M.A., Sir Michael Foster, K.C.B., D.C.L., Professor Percy Faraday Frankland, Ph.D., Sir Robert Giffen, K.C.B., LL.D., Professor William Dobinson Halliburton, M.D., F.R.C.P., Ernest William Hobson, Sc.D., Professor John Wesley Judd, C.B., LL.D., Professor George Downing Liveing, M.A., Professor Augustus Edward Hough Love, M.A., Adam Sedgwick, M.A., William Napier, Shaw, Sc.D., Captain Thomas Henry Tizard, R. N., C.B.

Professor John U. Nef, head of the Department of Chemistry of the University of Chicago, has been elected a member of the Royal Society of Science at Upsala, Sweden.

Professor E. J. Marey, of Paris, and Professor Camillo Golgi, of Padua, have been elected foreign corresponding members of the Vienna Academy of Sciences.

The Denny gold medal of the British Institute of Marine Engineers has been presented to Mr. C. W. Barnes for his paper on ship electric lighting.

Dr. Francis Ramaley, of the Department of Biology at the University of Colorado, at Boulder, has obtained leave of absence and will sail from San Francisco on December 22 for Japan. He will visit various botanical centers in the far east for purposes of study and for securing collections. During his absence the department will be in charge of Mr. Chancey Juday, M.A. (Wisconsin).

Dr. Maximilian Herzog, professor of pathology and bacteriology in the Chicago Polyclinic, has been appointed pathologist in the Bureau of the Government Laboratory, Manila, and will sail from San Francisco about December 30.

Mr. De Winton has resigned the acting superintendency of the Gardens of the London Zoological Society.

Sir John Gunn delivered the presidential address before the British Institute of Marine Engineers on November 23.

The New York Alumni Club of the University of Wisconsin will entertain President Charles R. Van Hise at dinner at the Murray Hill Hotel.

Professor Dicey, of Oxford, delivered the Sidgwick Memorial Lecture at Newnham College, Cambridge, on Saturday, November 21. His subject was 'The Relation of Law and Opinion as illustrated by the History of the Combination Laws during the Nineteenth Century.'

Mr. Cloudsley Rutter, of the U. S. Bureau of Fisheries, died on November 28, at Oakland City, Indiana, at the age of 36, after a short illness from erysipelas. Mr. Rutter was a graduate of the Indiana State Normal School and of Stanford University. He was a young man of unusual ability and energy, and had made very important studies of the salmon of our Pacific Coast, on which subject he was a recognized authority.

Dr. Cyrus Edson, at one time health commissioner of New York City, died on December 2, at the age of forty-six.

Professor Heinrich Moehl, director of the Meteorological Institute at Cassel, died on October 14.

Dr. Gary de Hough's collection of flies, especially Muscidæ (10,000 specimens), has been purchased for the Zoological Museum of the University of Chicago.

A special fund of $10,000 is being collected by the New York Botanical Garden for the purchase of plants, specimens and books and for defraying the expenses of botanical exploration in the West Indies, Central America and the Philippine Archipelago. The sum of $8,781 had been contributed on December 1.

There will be a meeting in the rooms of the Board of Trade and Transportation, New

York City, to consider the question of the dissemination of mosquitoes. Governor Murphy, of New Jersey, has been invited to preside, and addresses are expected from Dr. L. O. Howard and others.

It is said that a project for the establishment of a Behring Institute, after the model of the Pasteur Institute in Paris, is under consideration by the German Government. The primary objects of the new institute are to be the furtherance of research in the domain of serum therapy and the accurate preparation of serums of all kinds.

Nature, for November 26, gives the first place to the following note.

A rumor has reached us that at the annual meeting of the Royal Society on Monday next an attempt is to be made by a certain section of the fellows to upset the selection of officers made last week by the council. It appears that the physiologists are under the belief that they have acquired a prescriptive right to hold one of the two secretaryships. It is true that for upwards of forty years they have so held it, but the group of natural sciences includes more than physiology or even biology, and the council, in the exercise of its discretion, has thought that it was high time that one of the other sciences should be represented in this secretaryship. We are further informed that a copy of a letter is being circulated which appears to convey an invitation from the president and council to a certain physiologist to accept the vacant office. That letter was, it is stated, written in error, without the sanction or knowledge of the president and council, but in view of it a special meeting was called to consider the matter, when the council decided to adhere to the decision at which they had already arrived in the ordinary and regular way—a decision which is obviously in the best interests of the Royal Society as a whole, and doubtless the great majority of the fellows will support it by their votes on Monday.

UNIVERSITY AND EDUCATIONAL NEWS.

General F. M. Drake, of Des Moines, has bequeathed $50,000 to Drake University.

The fund left by Mr. Lewis Elkin for annuities for women teachers of the public schools of Philadelphia, is said to amount to $1,800,000.

A donor who wishes to remain anonymous has given, through Professor Sterling, £50,000 to University College, London, to be used for the promotion of higher scientific education and research.

Ottawa University, a Roman Catholic institution, was destroyed by fire on December 2. The loss is said to be at least $200,000, most of which is covered by insurance. Three of the priests were seriously injured. The main building of Jewell Lutheran College in Iowa has also been destroyed by fire. The loss is estimated at $25,000, one half being covered by insurance. One of the students was killed.

The Rev. George Morgan Ward has been elected president of Wells College, Aurora, N. Y.

Dr. C. H. Judd has been made acting director of the Yale Psychological Laboratory for the present year. At the same time an advisory committee on the laboratory has been appointed consisting of Professors Ladd, Duncan and Sneath.

Dr. James E. Lough, professor of psychology of the School of Pedagogy of New York University, has been appointed director of the summer school.

Dr. Horace Clark Richards, instructor in physics in the University of Pennsylvania, has been made assistant professor of physics.

At a meeting of the electors to the Wilde readership in mental philosophy, held on November 19, at Oxford, Mr. William McDougall, M.A., M.B., fellow of St. John's College, Cambridge, and reader in experimental psychology at University College, London, was elected reader in place of Mr. Stout, recently elected professor of logic and metaphysics in the University of St. Andrews. Mr. McDougall took the degree of B.Sc. with first-class honors in geology at Victoria University; he afterwards gained first-class honors in physiology and anatomy in both parts of the Natural Science Tripos at Cambridge.

Mr. Reinhold F. A. Hoernlé, B.A., Balliol College, has been elected to the John Locke scholarship in mental philosophy.

Mr. W. M. Fletcher, of Trinity College, Cambridge, has been appointed demonstrator of physiology.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FRIDAY, DECEMBER 18, 1903.

CONTENTS:

*THE ACTION OF RADIUM, ROENTGEN RAYS AND ULTRA-VIOLET LIGHT ON MINERALS AND GEMS.**

THE purpose of this paper is to recount the results of our investigations as to the conduct of the gems and gem-material of the Tiffany-Morgan collection under the influence of Roentgen rays, ultra-violet light and emanations of radium preparations. By the courtesy of the American Museum of Natural History, we were permitted to make a careful study of the action of these agents upon the minerals in the handsome Morgan-Tiffany and Morgan-Bement collections. These undoubtedly are the most complete collections of authenticated minerals and gems on exhibition in the United States. The fluorescence and phosphorescence resulting from the action of ultra-violet light upon about 13,000 verified minerals were carefully observed. In addition to the above, we had an opportunity to submit selected stones from about 15,000 British Guiana diamonds and two particularly handsome diamonds (one being a tiffanyite) and several carbonadoes to these influences, the products of the most modern scientific investigations.

As there is no uniform meaning accepted for the term 'fluorescence' and 'phosphorescence,' in the outset we wish to emphasize our interpretation. Jackson would have

* Presented before the New York Academy of Sciences, October 6, 1903.

them meaning the same. Perhaps they are in reality the same phenomena; but in this paper by fluorescence we mean a luminosity, more usually evidenced by a play of color, lasting only during the direct influence of the exciting agent. By phosphorescence, we mean the emission or propagation of ethereal stresses, which affect the optical centers, producing light, white or colored, which persists after the removal of the cause. Substances may, therefore, be both fluorescent and phosphorescent.

The radium preparations of the highest activity used in these investigations became the property of the American Museum of Natural History through the liberality of Mr. Edward D. Adams, a member of the Board of Administrators of the Museum and of the New York Academy of Sciences. His gift of the necessary funds was applied to the purchase of one portion of radium bromide of 300,000 activity and another of 1,800,000; uranium being taken as the standard at 1. The preparations were obtained from the Société Centrale des Produits Chimiques at Paris. Unfortunately, although the order was authorized and material assured, it has been impossible to obtain the bromide of the highest strength in time for presentation at this meeting. The results here announced have to do with the radium of 300,000 and of 7,000 activity (chloride) and 240 (chloride) and of 100 radium barium carbonate. The compounds of lower activity were purchased by the authors.

The intense penetrative powers of radium preparations have been previously noted by numerous investigators—as the Curies, Strutt, Rutherford and others—mentioned later. The bibliography is so extensive that no effort is made to give all the references in this abbreviated paper. A remarkable illustration, almost startling, of its penetration was demonstrated with the following experiments: Radium bromide of 300,000 activity was placed in a sealed glass tube contained in a rubber thermometer-holder, the top of which was tightly screwed down, and the whole placed in a water-tight tinned-iron box; over the box were placed, first, a heavy silver tureen 1.5 mm. thick, then four copper plates, such as are used for engraving, and finally a heavy graduated measuring-glass 10 cm. in diameter filled with water to a depth of 15 cm. A diamond was then suspended in the water and became fluorescent immediately. Whenever the tube with radium was withdrawn a distance of more than one meter, the fluorescence ceased, but was resumed on replacing the radium under the tureen. This experiment showed that the influence of the radium was exerted successively through glass, rubber, silver 1.5 mm. thick, four copper plates, glass 0.5 cm. thick, and finally 8 cm. of water.

With all these wonderful properties of radio-activity, there is yet a certain amount of discussion at the present time between the German and the French investigators. Some of the former say that radium of 300,000 activity seems to them improbable; and that no scientific man should take this expression seriously. They believe that if metallic radium is ever obtained its activity will not exceed 100,000. This view is reiterated by others, who also state that these activities are only surmised, that they are not accurately determined, and can not be sustained by definite measurements. Madame Curie unhesitatingly speaks of the difficulties attending accurate measurements of such high radio-activity.

Incidentally it may be well at this point to call attention to the complex nature of these radiations. While a number of researches from such physicists as Becquerel, Professor and Madame Curie, Meyer and von Schweidler, Giesel, Elster and Geitel, Villard and Rutherford have proved the

intricacies of the radiations of these radio-active bodies, without doubt the last named has given us the clearest conception of their nature. Professor Rutherford, as a result of his investigations, resolved them into three classes, which for convenience are designated α, β and γ rays. They possess the following characteristics:

I. "The α-rays are very slightly penetrating, and appear to constitute the principal part of the radiation. These rays are characterized by the laws by which they are absorbed by matter. The magnetic field acts very slightly upon them, and they were formerly thought to be quite unaffected by the action of this field. However, in a strong magnetic field, the α-rays are slightly deflected; the deflection is caused in the same manner as with cathode rays, but the direction of the deflection is reversed; it is the same as for the canal rays of the Crookes tubes.

II. "The β-rays are less absorbable as a whole than the preceding ones. They are deflected by a magnetic field in the same manner and direction as cathode rays.

III. "The γ-rays are penetrating rays, unaffected by the magnetic field, and comparable to Roentgen rays."

From the experiments given above it appears that the γ-rays alone suffice to intensify the fluorescent properties of the bluish-white tiffanyite diamond.

While it is quite beyond the scope of this paper either to contribute much that is novel as to the real nature of radium or even to speculate thereon, some reference to a few of the numerous recent researches is essential for a clear understanding of a part of that which follows.

Professors Rutherford, Soddy and Dewar, and Sirs William Ramsay, William Crookes and William Huggins, with Lady Huggins, have obtained helium from radium preparations which are luminous in the dark. Professors Soddy and Ramsay have obtained helium from thorium oxide, which is also radio-active, as first observed independently by G. C. Schmidt and Madame Curie. Indications are that the luminosity of radium has some relation with this stellar and telluric element and it has been intimated that its propulsion constitutes the α-rays. Professor C. Vernon Boys has even suggested that the tails of comets may be accounted for, perhaps, by the evolving of this form of radio-activity. W. E. Wilson and Joly have made the 'suggestion that the presence of radium in the sun might enter as an important factor in contributing to solar radiations.'

Radium preparations are to be had on the market from French and German sources which are *non-luminous*. We are not informed as to efforts to secure helium from this variety. We do know, however, that certain minerals, as willemite and kunzite, become strongly fluorescent and phosphorescent under the influence of luminous radium compounds. Further, as the result of experiment of one of us, we know that pulverized willemite immediately glows in the dark when in contact with non-luminous radium barium carbonate of 100 activity, as do also certain diamonds, and the minerals mentioned above.

Thorium dioxide does not become luminous in contact with the radium preparations we have been able to obtain, although Elster and Geitel state that a thorium oxide screen shows scintillating fluorescence even after positive electrification, similar to the zinc blende.

Why certain rays either alone or through their influence upon the surrounding media present the order of magnitude of visible light waves, we shall not undertake to say. It is quite evident, however, that particular substances, like the diamond, willemite, kunzite, etc., possess the power of 'stepping up or down,' as it were, the ethereal stresses propagated by the radium, so that visible

rays result, or the bombardment of electronic emanations produces such an effect. The luminosity can not be attributed solely to the α-rays, or helium, as thorium oxide does not respond (at least visibly to the eye unaided by magnifying lenses), unless it so happens that the helium exists in one radio-active body in a different form from that in the other. Further, we have tested a number of helium-bearing minerals and none responded to the strong radium bromide. It appears that the luminosity of such substances, so variable in their construction as those mentioned above, may be accounted for in a measure by the physical explanations adverted to; yet, the striking fact that four zinc compounds of totally different composition, willemite (zinc orthosilicate), zinc sulphide, zinc oxide and kunzite (which contains a fraction of a per cent. of zinc) all respond in the most pronounced manner to radium emanations, would indicate the presence of a new element, a 'radium-foil,' as it were, or some unusual combination of known chemical integers, which synchronize with the activities of this unique body, in fact radio-active responsive bodies. One is immediately reminded of the actinium that Phipson announced in the eighties as being present in zinc white. (This is not to be confounded with Debierne's actinium, resembling titanium, announced in 1898.)

Becquerel, as is well known, first observed that certain substances, without any previous artificial excitation, emit rays which affect a photographic plate in the dark. Non-luminous radio-active bodies readily give this evidence of the presence of 'Becquerel rays.' We have made a paint, composed of zinc sulphide and radium barium carbonate in linseed oil, for making prints directly upon sensitive photographic films. The exposures varied from thirty-five minutes to an hour, some being made through glass. This would indicate the production of actinic rays and, furthermore, rays differing from those of the ultra-violet, the transmission of which are interfered with by glass.

Selected gems were mounted in paraffine blocks, held in wooden frames, obtained by pouring the hydrocarbon, after melting in a water-bath, into especially constructed boxes about 18 x 27 cm. and 1.5 cm. deep. The wooden bottoms attached to the frames by screws were readily removed. Each 'plate' was numbered by placing small hot wire nails on the paraffine. Where gems of the same species varied in color they were arranged according to the spectrum as far as practicable. Comparisons as to color effects could thus be had, but of course no comparison of penetrative effects, as the stones were of variable thickness. They were photographed in place.

These plates admitted of a careful comparative examination of the gems when subjected to the bombardment of the Roentgen rays produced by a Queen's self-regulating Crookes' tube with a twelve-inch spark coil. Many radiographs were also obtained with variable exposures, the iron markers adverted to, through their impenetrability, serving to identify the plates.

Perhaps no such complete collection has been studied in this manner, although Doelter in 1896 published a most interesting study of the conduct of some sixty-five minerals and other precious stones when subjected to the Roentgen rays. During the same year J. B. Cochrane published a very practical paper on the testing of precious stones by Roentgen rays. Without giving details, it may be said that their observations were verified, and in general, it was learned that the penetration of gem material by these rays is a matter of degree rather than kind, and sharper contrasts were obtained with certain precious stones when they were surrounded by metals, like gold or lead, than was had when they were

radiographed alone. The observations of the late Professor Ogden N. Rood on the deflection of Roentgen rays by crystal or cut faces were verified.

J. E. Burbank in 1898 published a work on mineral phosphorescence produced by X-rays. Of all the substances tried, he found 'in general minerals containing ores of the metals are non-phosphorescent' and that fluorite and calcite seemed most suitable for experimentation. J. Trowbridge states: "By them (X-rays) an electrical charge is communicated to fluorescent and phosphorescent substances. The resulting electrical energy, in being dissipated (by heat), produces the phenomenon of light" (see below). Thomas A. Edison directed the Roentgen rays upon some eighteen hundred chemical compounds, artificial and natural, seeking a fluorescent screen. Later (1900) Bary examined the conduct of a number of salts under the influence of Roentgen rays. "Those which become fluorescent belong, with the exception of uranium, to the families of the alkalies and alkaline earths. Similar results were obtained by exposure to the radiations from a radio-active metal supplied by Curie."

Robert Boyle in 1663 appears to have been the first to have made a truly scientific examination of the phosphorescence of diamonds, although the alchemist, Albertus Magnus, in the thirteenth century, said he had seen a diamond which glowed when it was put in hot water. Bernouilli remarked that when a diamond is rubbed on gold it becomes luminous 'like a burning coal excited by the bellows,' as Draper put it. 'A light, too, that cannot be extinguished by water, and yet so ethereal and pure that it can set nothing on fire' attracts the scientific imagination as much to-day as it did then.

Two hypotheses were offered in the eighteenth century in explanation of phosphorescence:

1. Léméry in 1709 maintained that phosphorescent bodies act like sponges to light, absorbing it and retaining it by so feeble a power that very trivial causes suffice for its extinction.

2. DuFay in 1735 held that it resulted from actual combustion taking place in the sulphureous parts of the glowing body. He first noted that the substance requires previous exposure to light; it glows in the dark with decreasing luminosity. DuFay also observed the effect of interposing colored glass between the phosphorescent body and the light.

In 1859 J. H. Gladstone exhibited diamonds strongly fluorescent in the sunshine. Silvanus Thomson used one of these diamonds in 1896 in a lecture on luminescence at the Royal Institution.

We are not offering a complete history of fluorescence or phosphorescence, nor explanations of these fascinating properties; but hints are given below which may serve to assist in their elucidation.

MM. Mascart and Chaumet examined a number of gems under the influence of violet light. One of us (K.), in 1889, with Mascart, and with Hallock in 1894, submitted bluish-white, opalescent diamonds (from Bagagem Mines, Brazil—tiffanyite) to electric light passing through glass of different colors.

Although, as will be mentioned, such compounds as alumina, alkaline earth sulphates and certain rare earth oxides, have been examined in vacuum tubes under the influence of electric sparks, we are not aware of any very extended examination of mineral or chemical substances when subjected to ultra-violet light produced by sparking. E. Becquerel in his 'La Lumière, ses Causes et ses Effects' states that 'the electric spark acts only by its light, but its action is more energetic than that of the sunlight by reason of its great intensity and the proximity of the source.' Wieder-

mann and G. C. Schmidt, in an article on luminescence, reached the conclusion that the *violet* light alone of the electrical discharge does not cause phosphorescence, which is 'due to peculiar discharge rays analogous to cathode rays.' M. W. Hoffman confirmed the above. J. Trowbridge reported, 'The action of the X-rays on this mineral (fluorite) was exactly similar to that of electrification,' and concluded that 'by them (X-rays) an electrical charge is communicated to fluorescent and phosphorescent substances.'

While there may be no question as to the above statements for the particular materials examined—and they are doubtless true for many other substances—yet in our observations there are some which do not admit of the sweeping conclusion that all fluorescent and phosphorescent phenomena observed in minerals subjected to rays coming from the sparking of high voltage currents with iron terminals are due to electrification.

The ultra-violet light was produced by a triple spark through quadruple iron terminals (we may so designate them) with a high voltage current. The direct current was taken from a 110-volt circuit passed through a Ruhmkorff coil with a 12-inch spark and stepped up by two Leyden jars in series. The sparker was provided with a quartz window surrounded by vulcanite and otherwise insulated to permit comfortable handling. As the number of observations to be made was very great, it was impracticable to remove each individual specimen from the exhibition cases and storage cupboards to the dark room, although this was done in many experiments. Flexible cables 200 feet long were joined to the apparatus. This was placed upon rollers and could be moved easily to the various aisles between the cases. The Piffard lamp was joined up with the apparatus by insulated wires, further protected by rubber tubing, 36 feet long. About 13,000 minerals were thus examined by night.

A large mass of original material has been gathered, of which only a few general observations and tentative conclusions are here presented.

The three most responsive minerals to all three forms of activity were found to be willemite, kunzite and certain diamonds.

In a subsequent investigation with the still more rare and novel element actinium, the particulars of which will be given at the end of this paper, these same three minerals were found to respond markedly to that substance, though with some special features.

1. It was found that willemite from Franklin, N. J., is both fluorescent and phosphorescent with the Roentgen rays, ultra-violet rays and when exposed to radium emanations. These properties were retained, although in some instances the specimens were considerably altered by decomposition. Foreign specimens of the same species were not affected at all. The willemite retained its luminescence for more than twenty-four hours after it had been exposed to radium; the latter not being then within 100 feet of it. Willemite and diamond also responded to polonium that formed a coating on a bismuth rod.

Willemite has also been noted as triboluminescent, *i. e.*, emitting light upon attrition or percussion, even when it merely strikes the side of a glass in which it is suspended in water.

2. The calcite from Franklin, N. J., showed a distinct red glow with the ultraviolet rays. This mineral, as well as the associated willemite, showed very marked peculiarities of color, the willemite green and yellow-green, the calcite a red glow. These effects were so characteristic that it required but a moment to identify the

specimens in various parts of the collection as being from Franklin, N. J.

3. The gangue of all minerals from Pajsberg and Langban, Sweden, also showed this peculiar red glow; the limestone strikingly like the calcite from Franklin, N. J.

4. All the minerals from Borax Lake, California—the colemanite, hanksite, glauberite, iddingsite and many others—without exception phosphoresced with ultra-violet rays. The briefest exposure caused them to glow and to retain this luminescence for a considerable time; but none of these minerals either phosphoresced or fluoresced with radium; those tested with magnesium light phosphoresced.

5. Hydro-zincite, from Algiers, showed a remarkable fluorescence, bluish in color, different from anything in the collection.

6. Autunite and another uranium mineral, from Mitchell County, N. C., fluoresced wonderfully, while foreign specimens of the same species did not. Autunite appears to have two minerals present with it; one an orange and the other a lemon yellow; one pulverulent and the other in slight tabular crystals. The striking fluorescence obtained with ultra-violet rays was not produced

Radio-active Minerals. Madame Curie's Table of Ampères, Intensity 1.		Kunz-Baskerville Observations on Phosphorescence or Fluorescence with	Ultra-violet Light.	Roentgen Rays.
Uranium	2·3			
Pitchblende from Johanngeorgenstadt	8·3		—	—
Pitchblende from Joachimsthal	7·0		—	—
Pitchblende from Przibram	6·5		—	—
Pitchblende from Cornwallis	1·6		—	—
Cleveite	1·4		—	—
Autunite	2·7		+	+
Sipylite		Amherst Co., Va.	—	—
	0·1	Barkevik, Nor.	—	—
	0·3	(Auerlite) Green R., N. C.		
Various thorites	0·7		—	—
	1·3			
	1·4			
Orangite	2·0	Arendal, Nor.	—	—
Monazite	0·5	Cheyenne Co., Col.	—	—
Xenotime	0·03	Alexander Co., N. C.	—	—
Æschynite	0·7	Hitteroe, Nor.	—	—
Fergusonite (two samples)	0·4	Llano Co., Tex.	—	—
	0·1	Ytterby, Swe.	—	—
Samarskite	1·1	Berthier Co., Que.	—	—
Niobite (two samples)	0·1			
	0·3			
Tantalite	0·02			
Carnotite	6·2			
Columbite		Portland, Conn.	—	—
Monazite		Arendal, Nor.	—	—
		Zlatoust, Ural.	—	—
(171st St. and Washington Ave.)		N. Y. City.	—	—
		Amelia C. H., Va.	—	—
		Alexr. Co., N. C.	—	—
(Sand.)		Rio, Brazil.	—	—
		Tvedestrand, Nor.	—	—
Polycrase	near	Marietta, S. C.	—	—
Euxenite		Mitchell Co., N. C.	—	—

Column 1 is Madame Curie's list of rare minerals; 2 is K.-B. ultra-violet rays; 3, Roentgen rays. With one exception, neither of the latter shows any action.

when glass, which is opaque to these rays, was interposed.

The yellow mineral labeled 'greenockite,' from Franklin, N. J., fluoresced in an identical manner, leading one to infer that this is itself a uranium mineral, or else contains the same substance that causes the autunites to fluoresce.

A comparative table is appended. It is self-explanatory and serves to illustrate the conclusions apparently inevitable, namely, the presence of something not previously recognized.

7. Hyalite (botryoidal), on a trachytic rock, from San Luis Potosi, Mexico, as colorless as the purest water, fluoresced most intensely, with a rich British green color; but these specimens did not phosphoresce. This green fluorescence could be observed when the source of the ultra-violet rays was five or six feet away. It did not persist on the removal of the source, but flashed in when the rays played upon it. The sparker held near, but without the rays playing upon the specimens, gave no fluorescent effects. Therefore, no other conclusion is tenable than that it is the ultra-violet rays that produce this change. The same remark may be made for many of the experiments carried on with the sparker as the source of the ultra-violet light, in the examination of these mineral substances. On the other hand, this hyalite neither fluoresced nor phosphoresced when exposed to the magnesium light, Roentgen rays or radium, in this respect behaving like the minerals from Mono Lake; no hyalites from other localities responded to any of these activities.

8. By the action of ultra-violet rays a number of fluorites both phosphoresced and fluoresced; some phosphoresced and did not fluoresce; some fluoresced and did not phosphoresce; and some did neither. Further, their color had apparently no influence in determining this result; it can not be the fluorine or alkaline earth present that accounts for this variation, as artificial preparations gave negative results. It is more probably the presence of rare earths like yttrium and ytterbium. (A paper on this will appear.)

9. Chlorophane has long been known as a mineral very easily rendered luminous by heat. By some authorities it is stated, a century ago, that it was almost always luminous. This variety of fluorspar is found with other fluorspars—sometimes as a vein of purple between veins of green fluorspar. It proved very responsive to the ultra-violet rays. A variety from Amelia Court House, Virginia, became suddenly luminous from the heat of the hand.

This luminosity was lost upon further heating (about red heat) but the phosphorescent properties were restored in a measure by exposure to the Roentgen rays. Trowbridge has observed this with other fluorites (see above). The exquisite colored fluorescent properties were not regenerated however. Chlorophane is pyroelectric by attrition, and this peculiarity distinguishes it from the ordinary fluorites.

10. It was noted that gypsum from Sicily, when submitted to ultra-violet light, was from two to five times as responsive as specimens from Bavaria and other localities.

11. It was found that those topazes which had lost the sherry color—the tint so fleeting that some of the museums have been led to protect them from the light—showed no distinct phosphorescence with ultra-violet rays, while the unfaded crystals of that color responded, but no others.

12. Wernerite from New York phosphoresced, while specimens from foreign sources did not. Many apophyllites and calamines gave no response whatever.

13. Pectolite proved an exceptionally interesting mineral. Every specimen that was exposed to the ultra-violet rays showed

an active response; even some that were almost entirely altered to steatite. This is especially striking, as some of the specimens from New Jersey were loose delicate aggregates of needle-like crystals. Some were made up of crystals with a texture like felt; others of coarse crystals, and lastly the pectolite without any crystalline structure, homogeneous, and one time mistaken for jade, from Tehama County, California.

14. Wollastonite, whether from northern New York or associated with the rosolite garnet from Mexico, phosphoresced markedly, and with some duration, with ultra-violet rays, and responded strongly to radium (300,000).

15. Kunzite, the new variety of spodumene from Pala, California, when exposed to the action of radium of 300,000 activity for a few minutes, became wonderfully phosphorescent, the glow continuing persistently after the removal of the source of excitation. Six hundred grams of kunzite crystals were excited with 125 milligrams of radium bromide. Sir William Crookes in a personal letter, having repeated the experiment, remarks: 'I think this lilac variety of spodumene runs the diamond very close, if it does not surpass it sometimes.' Ultra-violet rays caused kunzite to phosphoresce for more than a minute This remark applies to the faded or colorless kind; the highly dichroic appears to resist. All forms of kunzite become phosphorescent with the Roentgen rays. So pronounced is this, that a large crystal excited for five minutes afterwards affected the film of a sensitive photographic plate. A thirty-second exposure caused three cut gems to glow first golden pink, then white for ten minutes, 20 times the duration of exposure to the X-ray, the glow penetrating two thicknesses of white paper. Another crystal of kunzite, exposed to the Roentgen rays for ten minutes, was then laid on a sensitive plate for five minutes. The resulting photograph was clear and distinct, but presented a very curious aspect not seen by the eye, as of a misty or feathery outflow from the side and termination of the crystal, suggesting an actual picture of invisible emanations. Kunzite is also pyroelectric, assuming a static charge, similar to topaz, when rubbed with a woolen cloth. It does not phosphoresce when heated.

16. The action of the quartz group was interesting. As a rule, quartz proper neither phosphoresced nor fluoresced with ultra-violet rays, allowing them to traverse it without any effect. Hence, the very few exceptions noted were doubtless due to the inclusion or intermixture of other substances. This was apparent in one or two cases of quartz pseudomorphs after barite and fluorite, which phosphoresced, evidently from the presence of some remainder of those minerals.

Chalcedonic quartz was also very unresponsive; one example only, from Uruguay, S. A., showing a bluish milky phosphorescence, and a specimen of agate in which one layer responded, between others that did not.

Opal, on the other hand, was frequently phosphorescent, very rarely fluorescent, and sometimes without any action. The variety quincite phosphoresced intensely, as did also specimens apparently pseudomorphous after gaylussite, which exhibited strong and long continued phosphorescence.

17. Among carbonates, calcite, witherite, strontianite and barytocalcite all phosphoresced; and aragonite, with occasional exceptions, was very marked in its action, far surpassing calcite. On the other hand, cerussite did not phosphoresce, save in a single specimen from Phœnixville, Pa.

There is here seen again the peculiar phenomenon noted in minerals from the Langban locality; and the suggestion is evident of the existence there, and at points where

similar exceptional results appear, as in Mono Lake, of the presence of some rare element (perhaps new) widely diffused in very minute quantities.

A similar indication is given by the behavior of the glauberite; those from Borax Lake, California, phosphoresced, as did those from Laramie and from Spain; while Chilian specimens did not.

18. It is notable that tourmaline, which is so markedly pyroelectric, gave no response; nor did beryl, save in three specimens from Haddam Neck, Conn.

19. American sapphires of various kinds, spinel, chrysoberyl, and almost all jades, declined to show any effects from ultra-violet rays. Most of the gem-minerals, except diamond, opal and kunzite, were little acted upon.

20. Only two of the rare earth oxides responded at all to the action of ultra-violet rays, namely, zirconium and thorium dioxides, which phosphoresced strongly. The thorium dioxide remained luminous in the dark for a greater length of time. The zirconium dioxide showed no radio-activity when tested by the electrical and photographic methods. It is strange that the two rare earths forming dioxides are the only ones to exhibit this property. The following oxides were examined: yttrium, ytterbium, erbium, gadolinium, samarium, lanthanum, cerium, neodidymium, praseodidymium, thorium, zirconium, titanium, uranium and variable mixtures of the same. They will be investigated further by one of us. (B.)

In view of the fact that these two earths give this characteristic response to ultra-violet rays, it became immediately of interest to learn the effect of these rays upon minerals carrying those substances in different proportions. The following selected minerals were subjected to the action of ultra-violet rays without a single one of them giving either fluorescence or phosphorescence.

Samarskite.—Berthier Co., Que.
Thorite (Orangite).—Arendal, Norway.
Thorite.—Barkevik, Norway.
Thorite (Auerlite).—Green River, N. C.
Sipylite.—Amherst Co., Va.
Columbite.—Portland, Conn.
Monazite.—Arendal, Norway; Zlatoust, Ural; 171st St. & Washn. Ave., N. Y., Amelia Court House, Va., Alexander Co., N. C.
Monazite sand.—Rio, Brazil.
Monazite.—Tvedestrand, Norway.
Xenotime.—Cheyenne Cañon, Colo.; Alexander Co., N. C.; Hitteroe, Norway.
Euxenite (in Samarskite).—Mitchell Co., N. C.
Æschynite.—Hitteroe, Norway.
Polycrase.—Near Marietta, S. C.
Fergusonite.—Llano Co., Texas; Ytterby, Sweden.

TENTATIVE CONCLUSIONS.

1. It seems as though in willemite, hydrozincite and the artificial phosphorescent zinc sulphide and zinc oxide, there is present, with the zinc, some element probably not yet determined, that possesses peculiar properties; one that in combination with a zinc mineral gives the high luminosity by the application of radium, the ultra-violet rays, or the Roentgen rays or other radio-active bodies; an element possibly accompanying zinc and possessing an affinity for it, as polonium has for bismuth, perhaps Phipson's actinium mentioned above.

2. It seems likely also that there exists in fluorspar either yttrium or ytterbium, or some other related rare earth, or perhaps several of them, from the variable action of this mineral with the various kinds of rays.

3. In the case of the numerous minerals coming from Borax Lake, so various in composition and yet all responsive alike to ultra-violet rays, there seems to be present some element which is very highly active, but is not responsive to radium, and which appears in every single mineral

found here. This is evidently a substance not necessarily radio-active itself, but one that may possess the same or allied properties with the substance found with the zinc minerals.

4. The substance present in calcite, from Franklin, N. J., and from Langban and Pajsberg, Sweden, is probably yet another body, which also does not respond to radium; although the willemite found with it at Franklin becomes luminous at the approach of radium as if it were a fairy wand.

5. There probably exists in autunite, and another yellow-brown uranium mineral from Texas, a fluorescent substance which differs from anything that we have noted in the study of the minerals of the collection.

6. In the hyalite, from San Luis Potosi, a volcanic mineral, there is present something that responds with a beauty of color that strikingly reminds one of nitrate of uranium; this may be still another substance.

7. The most responsive of all, however, were the diamonds containing that peculiar substance that gives them what is known as the blue-white color—fluorescent like anthracene, and holding the luminosity for a long time—to which one of us (K.) gave the name of Tiffanyite.

In the examination of more than 15,000 diamonds from British Guiana and elsewhere, 44 were selected. After an exposure of 60 seconds to ultra-violet rays, these 44 diamonds phosphoresced brilliantly and continued to glow for a long time after exposure. The luminosity was so great that it penetrated one thickness of white velvet and from nine to twelve thicknesses of tissue and blue linen paper. But they did not exhibit their light through black velvet, nor apparently were they affected by the ultra-violet rays when surrounded by black velvet. These diamonds when glowing brilliantly showed absolutely no action upon the barium platino-cyanide screen, nor upon screens of phosphorescent zinc sulphide, willemite or calcium sulphide.

The most remarkable specimen was a diamond of $14\frac{21}{32}$ carats. (This was exhibited.) This stone possesses the power of absorbing sunlight and emitting it in the dark. An arc lamp will cause it to store up light and to give it out in the dark. Even a small hand-lamp of one candle-power has caused this diamond to phosphoresce. It responds to polonium, to the Roentgen rays and to the utra-violet rays; to the rays that pass through a violet glass, and to radium, even in a more marked degree than willemite.

The print shown was made from a negative obtained by exposing a sensitive photographic plate to the blue-white diamond, and a transparent black stone of $16\frac{11}{16}$ carats, thin white paper intervening, after they had been exposed to ultra-violet light for one minute. The print is the result; except that the print of the black stone has been colored to show the reddish phosphorescence given out by it.

After another exposure of one minute, to our surprise, the black stone glowed red for fifteen minutes, almost surpassing the phosphorescence of the blue-white stone. At the end of fifteen minutes the red glow subsided, while the white stone phosphoresced five minutes longer; the light being held twenty minutes after exposure.

As stated above, from the work of Wiedemann and Schmidt, Hoffmann, and Trowbridge, it appears that the phosphorescent and fluorescent effects observed by the action of ultra-violet light, produced by sparking, with such metals as iron, is not due to this cause at all, but may be accounted for by the accumulation of an electric charge. The diamonds were

'grounded' by placing directly upon the iron radiator in the room and similar observations made, as when the precious stones were insulated.

It is interesting here to note that Marckwald reported the property of phosphorescence with polonium as belonging only to Brazilian diamonds. Rosenheim found that the rays from radio-active polonium possess the property of inducing fluorescence in a number of diamonds from different localities. The rays emitted by the diamonds under these conditions affect the retina and the photographic plate. "This actinic activity of the diamond," he says, "like its visible fluorescence, is entirely dependent on the presence of the polonium, not persisting after the removal of the latter. Even after long exposure to polonium rays no induced radio-activity could be detected." We found the fourteen and a half carat diamond from Brazil very responsive to the polonium; also some from British Guiana.

Almost all diamonds, of various weights and from many localities and of different colors, fluoresce and phosphoresce more or less with radium, except the black or carbonado. The degree to which these phenomena are observed is no criterion of the grade of the gem, however, as stones with flaws often fluoresced with even greater brilliancy than the pure ones.

8. It is quite evident through our study of the collection, that one or the other of these forms of luminosity and activity may have a value to detect elements or compounds that have escaped notice or are present in the minerals as impurities. These forms of investigation may also prove serviceable in chemical analyses. There should be a use for this line of research also in petrological determinations, as the slightest phosphorescence or fluorescence would aid in determining and locating a mineral, no matter how minute in quantity. This we have done in several instances.

The original ultra-violet lamp was that of Gorl, of Munich, altered by the English into the St. Bartholomew lamp, and again improved and made practicable in the United States under the name of the Piffard lamp, after Dr. H. G. Piffard, of New York. It is an instrument of great utility and, in the convenient form with which we worked, can not fail to prove a valuable mineralogical and chemical as well as medical adjunct. In fact, Dr. Piffard has used it with much success in medical practice. It will also be useful in many instances for mineralogical determinations—at times to detect impurities which have escaped analysts and others.

9. In all observations on the effect of radium, ultra-violet light and the X-rays to determine whether an object becomes fluorescent or phosphorescent under the influence of either, it is essential that the eyes become thoroughly accustomed to the change of conditions when one is in a dark room. This usually requires from ten to twenty minutes, and in some cases half an hour. Attention has been called to this by preceding observers. Whether it be due to the accumulation of the visual purple, which von Kries states is a substance that supplies the retinal basis of vision at low luminosities, and whose accumulation is accountable for the great increase in sensitiveness of the dark-adapted eye, or to the ordinary physical changes in the optical lenses, or partly to both, we do not undertake to decide. But it was found to be advisable that just before the source of excitation was removed from the material examined, the eyes be closed, and not opened again until after the removal. Else, as was noted, the residual flash that remained might be mistaken for phosphorescence. In most of the experiments carried on, three observers watched each

test. When there was the least disagreement, the tests were repeated a sufficient number of times until a unanimous agreement was arrived at.

10. The Roentgen rays have been used with great success to locate fractures, misgrowths, deformities and abscesses in the bony processes; but as far as we are aware, little success has attended efforts to locate ruptures, growths, or peculiarities of the veins, intestines, etc., by this means. There seems a possibility, however, that if a highly fluorescent or phosphorescent substance could be injected into the veins, the stomach or the intestines, it would be feasible to locate lesions, growths and other peculiarities of these organs; possibly also to locate accretions and kidney or bladder concretions, especially calcareous, as well as, possibly, peculiarities in the structure of the heart and other organs. This it might be practicable to do by means of inert but phosphorescing materials in solution given in the food, or injected into the stomach or intestines when they are quite empty. It might be that a nearer location could be effected in the organs desired to be examined, if impalpable powders be given with the food. It it were possible to inject such a substance into the blood, the entire vein structure of the body might be rendered visible as well as the bony part. It seems not unlikely that such an active agent as radium or ultra-violet light may yet be found a great accessory in diagnosis and autopsies, as they have given promise of marvelous curative values in certain diseases.*

11. The final part of the work planned was an investigation of the influence of cathode rays upon gems and the gem material of these collections. The method utilized in the classical investigations of Becquerel, Crookes and de Boisbaudran, on the fluorescence and phosphorescence of a number of substances, especially alumina and the rare earths, in vacuo, and spectroscopic examination of the light emitted therefrom, offers possibly an answer to questions as to the nature of such substances as give tiffanyite its unique properties, for example. Small amounts may be used; the destruction of such valuable gems in chemical analysis being out of the question. The time at our disposal having been utilized in securing the observations briefly outlined above, we were forced to discontinue the research for a time, although a number of Crookes' tubes have been charged with material and exhausted. We hope to complete that phase of the undertaking, but confess, from what has been indicated above, that things have been seen that shine like a 'pillar of fire by night' and beckon us on.

12. From the summarized observations on minerals related above, it appears that there are evidently two properties recognizable—radio-activity and a property that responds to this activity. It is hence seen that we have two classes of bodies—radioactive, and those that are affected by radioactivity; and that these groups may be again divided into several minor divisions.

We seem to find here an analogy to certain well-known facts in electricity and magnetism; some bodies that are active and others that are acted upon in several different forms, which are evidently closely related, and yet are distinct in their modes of action. We are privileged, therefore, to offer for mineral substances a

TENTATIVE CLASSIFICATION.

Those minerals:

1. Not responding to radium, ultra-violet or Roentgen rays.

2. Responding to radium only.

* After presenting this paper we were informed that Dr. Morton and Mr. W. J. Hamner have investigations along these lines now in progress.

3. Responding to ultra-violet rays only.
4. Responding to Roentgen rays only.
5. Responding to radium and ultra-violet rays (not to Roentgen rays).
6. Responding to radium and Roentgen rays (not to ultra-violet rays).
7. Responding to ultra-violet and Roentgen rays (not to radium).
8. Responding to radium, ultra-violet rays and Roentgen rays.

It is our purpose, further, to examine the same collections by the infra-red rays, for comparison with the ultra-violet; as it is quite possible that many minerals will give response of some kind with the infra-red that are not affected by the ultra-violet.

As for mineralogical determination, no large apparatus is necessary, as is used in medicine or for physiological investigations. In fact, very simple apparatus is sufficient. Therefore, we are devising a series of appliances such that the entire apparatus may probably be purchased for much less than one hundred dollars. And a photometer-like meter to measure the distance of penetration of the X-ray, the ultra-violet ray, and also the distance of the penetration of radio-active bodies.

We are also preparing a list of minerals, selecting those most readily obtainable, to illustrate these phases of activity or inactivity with the three useful accessories. For a small expenditure any school or college can obtain them for comparative study.

As the electric furnace has given us carborundum, artificial graphite and a series of absolutely *new* carbides, because with it we have attained temperatures of a height unknown before its introduction; and as the production of low temperatures has resulted in the liquefaction of all known gases and assisted in the discovery of new ones; so perhaps the application of these forms of energy may give us the means of identifying substances that have escaped all our earlier methods of observation; and it may be that we shall find a new series of elements. We are clearly on the threshold of a new field of scientific facts and perhaps generalizations and laws, which may yield results in the twentieth century as interesting and remarkable as the electrical discoveries were in the nineteenth. Indeed, some have already discarded atomic chemistry and assumed ionic chemistry, while pioneers like Crookes, J. J. Thomson and Lodge vouchsafe 'protyle,' 'corpuscles' and 'electrons,' with more or less experimental verification, although they do not quite reach Ostwald's metaphysical view.

Here we gratefully acknowledge the aid given us in free access to the collections, the construction of a special dark room, every facility of the museum's workshops, the encouragement and advice given by the museum's able director, Dr. H. C. Bumpus, and the attention and assistance of Dr. L. P. Gratacap, Mr. L. L. Seymour and Mr. Smith, of the mineralogical department, and of Mr. Dahlgren, the museum photographer.

SUPPLEMENTARY NOTE: ACTINIUM.

We have recently had the opportunity of making some experiments with a small amount of the exceedingly rare, novel, and hitherto almost unobtainable, element, actinium, described by Professor Debierne in the *Comptes Rendus,* 1898.

This actinium was a preparation of the oxide, with an activity of 10,000 (uranium being taken as unity), prepared by Dr. Debierne, and sent to one of us through the courtesy of Professor P. Curie. The emanations from it seemed most profuse, and although it had been exposed for two weeks, in a paper package in the mail, yet they were as energetic at the time of its arrival, and one week after, as they could have been at any time. The substance is wonderfully radio-active; in the few ex-

periments that we have made, it was found that, like radium, it causes the diamond to phosphoresce, and exerts the same action as radium upon kunzite and willemite, with the possible exception that the emanations from the small quantity of substance seemed to become luminous before they touched the willemite itself. The surface that was affected measured two square inches, many times the surface of the actinium. The effect produced on willemite was somewhat different from that due to radium; the luminescence apparently penetrated the willemite, and at the same time it almost seemed as if a luminous emanation left the material.

It was also found that on applying some powdered and granulated willemite to the inside of a closed jar, 12 cms. high, and putting this over the actinium, which was in a paper, the emanations made the entire interior of the jar luminous.

On the other hand, they do not appear to possess the penetrating power through glass that the radium compounds show; for in the same experiment they failed to affect the willemite on the outside of the jar, although the glass was only 1½ mm. in thickness.

A platinum-barium-cyanide screen immediately responded when the actinium was held against the black paper on the back. The abundance of emanations from the substance, rather than their penetrative quality, seemed to be its characteristic.

One of the properties of actinium which Professor Curie mentions in his letters, is the emitting of many emanations, which last for some minutes. This last feature, of endurance, was not observed. On the other hand, a peculiarity of actinium, as compared with radium, is that the emanations, although much more profuse, disappear in a few seconds. Another marked feature is a certain visibility or materiality of the emanations. This has been already referred to in some of the experiments above described in connection with willemite.

If actinium is placed in a paper over a screen of the phosphorescent sulphide of zinc (Sidot's blende), the screen will become illuminated, and on slightly blowing, so as to produce a current of air, the light is carried along the screen with the emanations. It was found that the diamond was affected quite as permanently as with radium; so was the spodumene variety, kunzite, and a specimen of willemite more than two inches square. Emanations of the actinium, which was in a double paper, rose in a cone-shaped form and spread out in an inverted cone on the base of the willemite, illuminating both.

George F. Kunz,
Charles Baskerville.

AMERICAN ORNITHOLOGISTS' UNION.

The twenty-first congress of the American Ornithologists' Union convened in Philadelphia, Monday evening, November 16. The business meeting was held in the council room, and the public sessions, commencing Tuesday, November 17, and lasting three days, were held in the lecture hall of the Academy of Natural Sciences.

Charles B. Cory, of Boston, was elected president, Charles F. Batchelder, of Cambridge, Mass., and E. W. Nelson, of Washington, D. C., vice-presidents; John H. Sage, of Portland, Conn., secretary; Dr. Jonathan Dwight, Jr., of New York City, treasurer; Frank M. Chapman, Ruthven Deane, A. K. Fisher, Thos. S. Roberts, Witmer Stone, William Dutcher and Charles W. Richmond, members of the council.

The ex-presidents of the union, Drs. J. A. Allen and C. Hart Merriam, and Messrs. William Brewster, D. G. Elliot and Robert Ridgway are *ex-officio* members of the council.

Dr. Samuel W. Woodhouse, of Philadel-

phia; Professor Dean C. Worcester, of Manila, P. I.; Dr. E. C. Hellmayer, of Munich; Dr. Emil A. Goeldi, of Pará, Brazil; Dr. Peter Sushkin, of Moscow, and Dr. Herluf Winge, of Copenhagen, were elected corresponding fellows. Eight associates were elected to the class known as members, and one hundred and four new associates were elected.

At the opening of the congress Dr. A. K. Fisher delivered a memorial address on Thomas McIlwraith, who died in Hamilton, Ontario, January 31, 1903. Mr. McIlwraith was a founder and fellow of the union, and, although deeply engrossed in business, never lost his taste for ornithology. His writings relate mainly to the birds of Ontario, Canada.

Mr. Frank M. Chapman, in his account of an ornithological trip to the Pacific, brought forcibly to mind the exceptional opportunities afforded the eastern members of the union, by the Cooper Ornithological Club, to study the avifauna of the Pacific coast after adjournment of the special meeting of the American Ornithologists' Union held in San Francisco during May, 1903. Other results of the trip were shown at the present congress. Dr. T. S. Palmer spoke of the bird colonies of the California and Oregon coasts. Mr. Chapman exhibited most excellent views of Farallone bird life and described the different species found there, and Otto Widmann gave a list of the birds noted during a short stay in the Yosemite Valley.

A paper on bird life on Laysan Island, Hawaiian group—an interesting but little-known region—was presented by Walter K. Fisher and accompanied by fine examples of bird-photography. In the absence of the author the paper was read by Dr. A. K. Fisher, who also explained the slides. Laysan is said to be 'the greatest bird island in the world.'

Rev. H. K. Job showed a large series of lantern slides from photographs of birds taken in the bird rookeries of Cape Sable and the Florida Keys, and told of the ingenious expedients resorted to to secure good results.

Mr. Witmer Stone had gathered all obtainable material relating to John K. Townsend and William Gambel, and incorporated it in a paper of historical interest regarding these neglected ornithologists.

Mr. Geo. Spencer Morris spoke of bird life at Cape Charles, Va., and referred to the decrease in recent years among the water fowl found at that noted resort.

'New Bird Studies in Old Delaware,' by Samuel N. Rhoads and C. J. Pennock, brought out valuable ornithological facts relating to that apparently neglected state.

In his report of the Committee on Protection of North American Birds Mr. William Dutcher, the chairman, showed that satisfactory results had been obtained during the past year. This was made possible by the Thayer Fund money secured through the efforts of Mr. Abbott H. Thayer.

Following is a list of the papers read at the sessions:

In Memoriam: Thomas McIlwraith: A. K. Fisher.

Notes on the Bird Colonies of the California and Oregon Coasts: T. S. Palmer.

Nesting Habits of Florida Herons: A. C. Bent.

New Bird Studies in Old Delaware: Samuel N. Rhoads and C. J. Pennock.

The Æsthetic Sense in Birds: Henry Oldys.

Notes on the Protected Birds on the Maine Coast, with Relation to Certain Economic Questions: A. H. Norton.

Exhibition of Lantern Slides of Young Raptorial Birds, photographed by Thos. H. Jackson, near West Chester, Pa.: Witmer Stone.

Views of Farallone Bird Life: FRANK M. CHAPMAN.

The Bird Rookeries of Cape Sable and the Florida Keys: HERBERT K. JOB. Illustrated with lantern slides.

A Winter Trip in Mexico: E. W. NELSON. Illustrated with lantern slides.

Some Nova Scotia Birds: SPENCER TROTTER.

Nesting Habits of the Whip-poor-will: MARY MANN MILLER.

Some Variations among North American Thrushes: J. DWIGHT, JR.

The Spring Migration of 1903 at Rochester, N. Y.: E. H. EATON.

Warbler Migration in the Spring of 1903: W. W. COOKE.

Some Birds of Northern Chihuahua: WM. E. HUGHES.

A Reply to Recent Strictures on American Biologists: LEONHARD STEJNEGER.

The Exaltation of the Subspecies: J. DWIGHT, JR.

Variation in the Speed of Migration: W. W. COOKE.

An Ornithological Excursion to the Pacific: FRANK M. CHAPMAN. Illustrated with lantern slides.

Bird Life on Laysan Island: WALTER K. FISHER. Illustrated with lantern slides.

Ten Days in North Dakota: W. L. BAILY. Illustrated with lantern slides.

Two Neglected Ornithologists—John K. Townsend and William Gambel: WITMER STONE.

Bird Life at Cape Charles, Virginia: GEORGE SPENCER MORRIS.

San Clemente Island and its Birds: GEO. F. BRENINGER.

Yosemite Valley Birds: O. WIDMANN.

The Origin of Migration: P. A. TAVERNIER.

A Contribution to the Natural History of the Cuckoo: M. R. LEVERSON.

Mortality among Young Birds due to Excessive Rains: B. S. BOWDISH.

Collecting Permits: Their History, Objects and Restrictions: T. S. PALMER.

Report of the Chairman of the Committee on the Protection of North American Birds: WM. DUTCHER.

The next annual meeting will be held in Cambridge, Mass., commencing November 28, 1904.

JOHN H. SAGE,
Secretary.

SCIENTIFIC BOOKS.

JOHNS HOPKINS HOSPITAL REPORTS. VOL. 11, NOS. 1-9.

THIS report contains three articles. The first is an exhaustive and valuable monograph on pneumothorax by Dr. Emmerson, covering 450 pages. The literature of the subject, going back to the works of Hippocrates, and coming down to the present time, is given in the form of abstracts, translations or quotations from the original articles. This necessitates much more space than is usually devoted to literature, but it must be admitted that in many respects it is more satisfactory than the references ordinarily made. The first chapter is devoted wholly to these abstracts. In Chapter II., entitled 'The History of Pneumothorax,' the facts stated in the abstracts already given are satisfactorily woven together. Chapter III. is devoted to the etiology and pathology of the disease, with clinical histories of cases. While there is much of interest in this chapter, it can not be said that it contains any important contribution to our knowledge of the disease. Chapter IV., on 'The Mechanism of Pneumothorax,' is, in our opinion, the most interesting, and in some respects the most valuable part of this monograph. Your reviewer has been especially interested in the work done by Dr. Emmerson, as well as the literature which he has collected bearing upon the composition of the gas accumulation in the chest in this disease. His conclusions are stated as follows:

"1. There is a rapid accumulation of CO_2 in the pleuræ after death, which fact rules out the majority of analyses yet published.

"2. The presence of a purulent exudate is an important element in determining the composition of the gas.

"3. This post-mortem accumulation of CO_2 may explain the high tension of the gas, which hisses from the chest on the autopsy table.

"4. The method of diagnosing an open fistula proposed by Leconte and Demarquay seems to be valid."

Preceding authors have largely, if not altogether, failed to recognize the fact that the composition of the gas found in the pleura in pneumothorax is, in part at least, dependent upon the character of the microorganisms contained in the accompanying exudate. We know that certain bacteria consume oxygen and give off carbonic acid gas, while still others break up proteid material and elaborate H_2S and possibly $(NH_4)_2S$. It is not, therefore, surprising that there has been much diversity of statement concerning the composition of the gas in pneumothorax. Our author certainly makes it clear that these variations are to be expected.

The second paper is entitled 'Clinical Observations on Blood Pressure.' This is always an interesting subject to both the physiologist and the clinician. The instrument used in these observations was a modified Riva-Rocci sphygmomanometer, which gives very satisfactory results. The experiments made upon the effects of anesthesia upon blood pressure confirm the views now quite universally held by the best surgeons in this country; that is, that chloroform, on account of its depressing action, and the consequent low blood pressure, is a much more dangerous anesthetic for surgical operations than ether. The authors of this paper, Cook and Briggs, bring out the fact, so well known to obstetricians, that the depressing action of chloroform is not manifest when this anesthetic is used in labor. The most interesting part of this paper, to your reviewer, at least, is that which deals with the effects of strychnin and digitalin in cases of shock. Most clinicians of wide experience have become very positively convinced that strychnin, especially, is valuable in shock, but this has recently been denied by Crile, whose most interesting and valuable work upon this subject demands respect. Crile holds that the employment of strychnin in shock is irrational because, according to him, in this condition the vaso-motor center is completely exhausted, and no good is to be secured by 'flogging the tired horse to death.' Notwithstanding the conclusion reached by Crile, the majority of clinicians think that they have had in their experience ample and frequently repeated evidence of the value of strychnin in shock, and it is gratifying to know that Cook and Briggs in the paper now under review have shown that in eight out of ten cases of shock under central stimulation with strychnin, digitalin or cocain, positive improvement has been secured. It is only fair to state that this difference between Crile and other clinicians is largely a matter of words. Crile recognizes as 'shock' only those cases in which strychnin does no good, and he designates by the term 'collapse' other cases in which central stimulation is of value; but inasmuch as no one, not even the operator himself, can distinguish between the two in many instances, the clinician will undoubtedly continue to use strychnin in shock, and in doing this will be justified by the experimental observations recorded in the article now under consideration.

The third paper in this volume is entitled 'The Value of Tuberculin in Surgical Diagnosis,' and is presented by Dr. Tinker. While this article is of value, inasmuch as it confirms the findings of a number of others who have investigated the subject, it can not be said to furnish us with anything new. The author concludes that tuberculin, properly employed, is a valuable agent, and, we may say, the most valuable agent in our possession in the diagnosis of latent tuberculosis, and is harmless.

V. C. Vaughan.

SCIENTIFIC JOURNALS AND ARTICLES.

The Psychological Review will hereafter be edited by Professor J. Mark Baldwin, of the Johns Hopkins University, and Professor H.

C. Warren, of Princeton University. The editors announce that beginning with January 15, there will be issued monthly a literary section devoted especially to reviews of the literature.

The British Journal of Psychology, edited by Professor James Ward and Dr. W. H. R. Rivers, of Cambridge University, with the cooperation of Messrs. W. McDougall, C. S. Myers, A. F. Shand, C. S. Sherrington and W. G. Smith. The first number will be published in January by the Cambridge University Press and the parts will thereafter be issued at irregular intervals, about 450 pages constituting a volume, the price of which is 15s. The following papers will appear in early numbers:

J. WARD: 'On the Definition of Psychology.'

C. S. SHERRINGTON: 'On the Interrelation between Corresponding Retinal Points.'

J. L. McINTYRE: 'A Sixteenth Century Psychologist, Bernardino Telesio.'

W. McDOUGALL: 'The Sensations Excited by a Single Momentary Stimulation of the Eye.'

C. S. MYERS: 'The Taste-names of Primitive Peoples.'

R. LATTA: 'A Case of Recovery from Congenital Blindness.'

W. H. R. RIVERS: 'Observations on the Senses of the Todas.'

Also papers by F. W. MOTT, A. F. SHAND, H. HEAD and others.

The Proceedings of the Psychological Society will also be published in the Journal.

MR. F. SHILLINGTON SEALES will, from January next, edit in *Knowledge* the columns devoted to microscopy; still further space is to be given to this subject in our contemporary in the new year.

THE catalogue division of the Library of Congress has sent to press, and will issue shortly, through the office of card distribution, a set of analytics for Engler-Prantl's 'Die natürlichen Pflanzenfamilien.' Each article (family) in this important set of monographs will be represented by a separate catalogue card, which contains full bibliographical information, including exact dates of publication for undated signatures. Beside subject headings, all added entries will be printed in full. The cards covering the unfinished portions of the work will be issued upon the completion of the volumes in question. The number of titles now going to press is 458, and the total number of cards necessary for main entries, subjects and added entries will be 936. These may be obtained at the office of card distribution. The task of analyzing this and other collective works of similar importance, titles of which will be announced later, has been performed by Mr. J. Christian Bay. Owing to the exacting demands of necessary work in other directions, the library has so far undertaken but little work of this character.

DISCUSSION AND CORRESPONDENCE.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

TO THE EDITOR OF SCIENCE: As the St. Louis meeting of the American Association and its allied societies is drawing near, I beg the privilege of making, through the columns of SCIENCE, a suggestion to those, who I hope are many, intending to appear before Section B at that meeting. I think the general opinion of those who attended the Washington meetings of this section and of the Physical Society, which cooperated, is that the matter presented was, as a rule, very good, and that the manner of presentation was, as a rule, very bad. The habit of us physicists is to put in, before the meeting, a very modest claim for time, ten or fifteen minutes, when we have ample material for twenty or twenty-five, and then when we have the floor, to proceed as if we were giving a one-hour lecture in a course running through the year. Very few of our talks at society or association meetings give the impression of being thoroughly thought out, with a view not only to the subject, but to the audience as well. What we call 'papers' are apt to be rather disordered, imperfectly considered remarks about our papers, which in some cases are still to be written.

My suggestion is that every man who intends to make a communication to Section B at the coming meeting shall ask for as much time on the program as he is at all likely to need, and that, keeping his time allotment

strictly in view, he shall strive, days in advance, to put his matter into the most intelligible and attractive form. It should be remembered, too, that in the oral presentation of a subject before a friendly audience, it is better to give the hearers a chance to ask for more information, if they want it, or for fuller proof of statements made, if they think it needed, than to overwhelm and deaden them from the outset with a mass of details and an elaboration of argument.

Edwin H. Hall,
Vice-president of Section B.

THE ST. LOUIS CONGRESS OF ARTS AND SCIENCE.

To the Editor of Science: By chance, I had at first overlooked Professor Dewey's reply (Science, November 20) to my letter concerning the St. Louis Congress (Science, October 30). My answer thus comes late, but fortunately, the matter itself needs no further word, since all the questions involved, as far as they are of scientific import, were fully disposed of in my long letter. But Professor Dewey, in spite of the friendly tone of my answer, has now introduced in a most surprising manner a personal element, and that forces me to send a word of reply after all. He does not discuss the statements of my letter, by which practically all of his previous objections are proved futile, but he now turns the question so as to make it appear that I have made claims in my May article in the *Atlantic Monthly* which I had no right to make; he even ends with the climax that excuses are due from me to the editor and the readers of the *Atlantic.*

I had claimed in the *Atlantic* that the program of the congress adopted by the proper authorities involved a certain philosophical standpoint and a certain logical view of the sciences. When Professor Dewey expressed in his first remarks the idea that the program might exclude those who hold other views, I used the chief part of my reply to show that such a fear is unjustified. I showed that a man may have any views as to the logical relations of the sciences, and yet contribute in his special section with full freedom in spite of the framework of our program. It is evident that my article and my letter harmonize perfectly. But Professor Dewey considers the fact that I did not speak of the philosophical bearing once more in my letter as a kind of confession that such bearing does not and probably never did exist.

I did not repeat my assertion because I had stated the case very fully in the *Atlantic;* but there was not the slightest reason to withdraw a single word. No one who understands anything of methodology can see the program without observing that it has a meaning as a whole only when certain philosophical views are accepted. In the meetings of the boards for final decision I explained the logical reasons for this specific classification fully, and, accustomed to the rhythmical attacks of Professor Dewey on my philosophy, I pointed out why a philosophy like his would appear to me an unsatisfactory basis for the work of the congress and why an idealistic program was essential. Perhaps I may add an external proof of the correctness of my assertions. When my exposition of the situation had appeared in the *Atlantic Monthly,* the director of the congresses asked me to allow it to be reprinted as a pamphlet for official distribution—in short, if Professor Dewey insists that apologies are due in connection with my *Atlantic Monthly* essay, it seems clear that they are not due to the editor and to the readers, but to the contributor.

Hugo Münsterberg.

Harvard University,
December 3, 1903.

RIGHT-HANDEDNESS: A PRIMITIVE AUSTRALIAN THEORY.

The attempts of primitive peoples to explain biological or physiological facts are not always of a purely mythic order. The blacks of the Tully River, North Queensland, Dr. Roth (*N. Queensl. Ethnogr. Bull.,* No. 5, 1903, p. 25) informs us, 'say, that at actual birth, according as the child presents its face to the left or to the right, so will it be left- or right-handed throughout life.' This seems a clear instance of aboriginal 'scientific' reasoning, and the theory deserves record at least in the history of the discussion of the question.

The blacks of the Pennefather River account

for right-handedness and left-handedness in quite a different way. According to their belief, Anjea, the mythological fashioner of babies makes them all right-handed, but Thunder (who really existed before Anjea and made him) can also form infants and, whenever he makes any, they are all left-handed.

ALEXANDER F. CHAMBERLAIN.
CLARK UNIVERSITY,
November 6, 1903.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES. SECTION OF GEOLOGY AND MINERALOGY.

THE regular meeting of the section was held on November 16 at the American Museum of Natural History. The first business was the election of officers for the year 1904, and Professor James F. Kemp was elected chairman, and Dr. Edmund Otis Hovey, secretary.

The first paper of the evening was by Doctor A. W. Grabau, of Columbia University, and was entitled 'Discussion of and Suggestions Regarding a New Classification of Rocks.' The speaker said in part that all classification ought, as far as possible, to be genetic or according to progressive development. Such a classification is practicable in the biologic sciences, but not in those which, like mineralogy, deal with inorganic substances. In developing his theme the speaker suggested the following provisional subdivisions: Endogenetic rocks, or those formed by chemical means, and exogenetic or clastic rocks, which are chiefly of mechanical origin. The first group was further subdivided into pyrogenic or igneous rocks; hydrogenic or aqueous rocks; biogenic or organic rocks. The hydrogenic and biogenic rocks were each again subdivided into rocks of calcareous, silicious, ferruginous, carbonaceous and miscellaneous composition; and a further subdivision was made into unaltered and altered or metamorphic types.

The exogenic or clastic rocks were divided into autoclastic, hydroclastic, pyroclastic, bioclastic and anemoclastic.

A further subdivision according to texture was into rudaceous or conglomeratic, arenaceous or sandy, and lutaceous or mud rock.

The next division was according to composition into two main groups, silicious and calcareous, and finally into unconsolidated and consolidated and metamorphic rocks.

In the discussion of the paper Professor Stevenson spoke of the value of such a classification through its giving to teachers ideas for presentation to their classes regarding the interrelations of rock. Professor Kemp spoke of the system as being well adapted to geologic study on account of its giving the surroundings in which any specified rock has developed, although it is not practicable to assign a place to every small rock group which is really of mineralogical rather than of geological value.

The second paper of the evening was by Wallace Goold Levison, 'Notes on Fluorescent Gems.' The author said, in abstract:

Fluorescence, or the property of reducing the wave-length of certain luminous rays, enhances the beauty of a few colored gems under conditions which lessen the effectiveness of others that do not possess this property. Garnet, for instance, which is non-fluorescent, loses its rich crimson color and becomes dull gray in pure blue light. On the contrary, most kinds of ruby and ruby spinel and pink topaz respond to light rays above the red on account of their fluorescence, and in blue-violet light still display their characteristic tints. The red color of the ruby is somewhat developed by the light of the air-gap spark and an uncovered Crookes tube. It is intensely excited by the cathode rays. Willemite displays a beautiful greenish-yellow color not only in ordinary light rich in the yellow-green rays, but also in light consisting chiefly or wholly of the more refrangible colors in which its characteristic color would be effaced but for the possession of fluorescence in high degree. This mineral is excited furthermore by some of the ultra-violet rays and by the Roentgen and Becquerel rays.

Other materials which owe desirable tints to fluorescence are pearl, opal, hyalite, chalcedony and kunzite (the new lilac spodumene). Hiddenite, the green spodumene, seems to be non-fluorescent. Impaired by fluorescence are

triphane, a yellowish-green spodumene, which exhibits pink fluorescence in blue light; emerald, which shows crimson fluorescence in the upper part of the spectrum, and diamond, with greenish-blue to blue fluorescence excited by several kinds of energy but more or less masked in ordinary light.

In fluorescent substances excitation produces a certain opalescence or milkiness which is sometimes of sufficient strength to be of importance. It can not be taken as an indication of impurities in the materials. In the white diamond such a phenomenon is a detrimental quality.

Fluorescence affords a simple and positive method of distinguishing some of the fluorescent gems from imitations. Glass is not fluorescent and hence is easily detected. Other compositions when fluorescent show different colors from the genuine stones. In doublets the cement appears as an opaque film and the components differ in behavior. Artificial pearls of high grade have not been examined, but probably they will behave like the genuine. Artificial, or 'regenerated,' ruby has been examined in a single specimen. It acts like the natural stone in blue light, while with the air-gap spark between iron or aluminum electrodes it has a brighter color than any of the several natural rubies which were examined.

The following gems were stated to be non-fluorescent: Garnet, amethyst, Spanish topaz, yellow Brazilian topaz, sapphire, ordinary beryl, possibly Siamese ruby.

In the discussion of Mr. Levison's paper Professor Kemp expressed the hope that there would be a practical outcome from such investigations which would enable those not experts to detect false or artificial gems; Mr. Kunz said that there were simpler ways than the use of fluorescence for the determination of gems, and Professor D. S. Martin emphasized the desirability of getting definite information as to the wave-lengths to which gems respond.

The third paper of the evening was 'Mineralogical Notes,' by Dr. George F. Kunz, in the course of which the author exhibited white compact garnet from Fresno County, California, associated with the newly described compact vesuvianite, or 'californite.' In connection with these two compact minerals attention was called to the third compact mineral 'pectolite,' which was described some years ago by W. P. Blake. Pyroelectric zinc blende associated with wollastonite from Mariposa County, California, also was exhibited.

Edmund Otis Hovey,
Secretary.

THE TORREY BOTANICAL CLUB.

The club met at the Botanical Garden on November 25.

Dr. Britton read a memorial on the life work of the late Mr. Cornelius Van Brunt. It was ordered spread on the minutes and printed in *Torreya* as part of the proceedings.

The principal paper on the scientific program was by Mrs. Britton, entitled 'Notes on Further Botanical Explorations in Cuba.' The party consisting of Dr. and Mrs. Britton and Mr. Percy Wilson went to Cuba by way of Tampa, Florida, going direct to Matanzas, which point was reached on August 27. Extracts were read from her diary giving an interesting account of the daily happenings during the exploration of the region about Matanzas, Cardenas and Sagua. Many photographs were shown illustrating the regions visited, and specimens of some of the more conspicuous plants were exhibited. As the herbarium material secured by the expedition has not yet been studied, no detailed account of the botanical features of the region was attempted. All of this part of the island has been devastated by war. There is no primitive forest, and comparatively few large trees are left standing. On the return a few days were spent in Havana, visiting the botanical institutions of that city.

Dr. Britton exhibited specimens of what seem to be two species of hackberry. The common *Celtis occidentalis* of the eastern states is a small tree seldom exceeding forty feet, having smooth, slightly acuminate leaves and globular orange-colored fruits. On an excursion of the Torrey Club to the Delaware Water Gap some years ago, some much larger trees were observed growing in moist locations and having long acuminate leaves and oval

fruits. This seems to be the *Celtis canina* of Rafinesque. It is somewhat widely distributed, its range overlapping to some extent that of *C. occidentalis,* but it always occurs on moister, richer lands and grows to be a much larger tree.

F. S. Earle,
Secretary.

THE BIOLOGICAL SECTION OF THE ACADEMY OF SCIENCE AND ART OF PITTSBURGH, PA.

The section held its first regular business meeting, Tuesday, November 3, in the lecture hall of the Carnegie Institute.

The section was organized on October 9 by a number of members of the academy, who are interested in biological science. The officers of the section are:

President—George H. Clapp.
Vice-President—Professor R. H. Ridgeley.
Secretary-Treasurer—Frederic S. Webster.

President Clapp introduced the speaker of the evening, Dr. A. E. Ortmann, curator of the department of invertebrate zoology of the Carnegie Museum, who addressed the section 'On the Progress of Zoogeographical Investigations during the Last Ten Years,' which was followed by a general discussion by members of the section.

Regular meetings of the section will be held on the first Tuesday evening of each month.

Professor J. B. Hatcher, Dr. A. E. Ortmann and Professor Edward Rynearson were appointed as members of the 'Publication Committee.'

Frederic S. Webster,
Secretary-Treasurer.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY GEOLOGICAL JOURNAL CLUB.

The club, which organized in October, 1903, has, during the past month, reviewed the following articles:

R. H. Allen, 'The Oil Fields of the Texas and Louisiana Coastal Plain' (by C. W. Hayes and William Kennedy, in Bull. 212 U. S. G. S.); S. Shapira, 'Copper Deposits of New Jersey' (by W. H. Weed, in Geol. Surv. N. J. An. Rep., 1902); F. S. Elliot, 'Topographic Features of the Yosemite Valley' (by J. C. Branner, in *Jour. Geol.,* September–October, 1903); E. Burton, 'Earth Movements in the Bay of Naples' (by R. T. Günther, in *Geog. Jour.,* September, 1903); H. W. Shimer, 'The Skull of the Imperial Mammoth' (*National Geog. Mag.,* October, 1903); Mr. Shimer also spoke of other fossil mammoths and of boring clams; W. G. Ball, 'Mining in the Kirghez Steppes' (*Eng. and Min. Jour.,* November 14, 1903); C. E. Danforth, 'Cretaceous Auriferous Conglomerate of the Cottonwood Mining District, California' (*Eng. and Min. Jour.,* October 31, 1903); R. W. Senger, 'Lithia Deposits' (by W. F. Shaler, in *Bull. Univ. Cal.,* Vol. III., No. 13); M. Rubel, 'Notes on the Michipoten Gold Belt' (*Eng. and Min. Jour.,* October 31, 1903); G. G. Wald, 'Some Natural Resources of Michigan' (An. Rep. Mich. Geol. Surv.).

The following papers were given:

Professor W. O. Crosby, 'The Deflection of the Merrimac River,' also 'A Description of the Formation at the Old Nickel Mine at Dracut, Mass.'; F. G. Clapp (U. S. G. S.), 'Methods of Geological Surveying in Western Pennsylvania'; G. F. Loughlin, 'The Formation at Mine La Motte.'

G. F. Loughlin,
Secretary.

ASSOCIATION OF TEACHERS OF MATHEMATICS IN THE MIDDLE STATES AND MARYLAND.

On Saturday, November 28, about 300 teachers met in the Milbank Memorial Hall, Teachers College, New York City, and organized an Association of Teachers of Mathematics in the Middle States and Maryland. Almost all the colleges and large schools within the territory named were represented, and considerably more than 200 persons enrolled as foundation members of the society, whose prime object is the improvement of mathematical teaching. Professor David Eugene Smith, of Teachers College, was elected president of the association; Professor H. B. Fine, of Princeton University, vice-president; and Dr. Arthur Schultze, of the High School of Commerce, New York City, secretary.

The meeting, which consisted of a morning and afternoon session, offered many points of interest to mathematical teachers. After President Butler of Columbia University had delivered the address of welcome, papers on various phases of mathematical teaching were read by Mr. Harry English, of Washington, D. C., Mr. Isaac N. Failor, of Richmond Hill, Mr. Arthur Schultze, of New York City, and Mr. J. L. Patterson, of Philadelphia.

A mathematical exhibition of models, calculating machines, teaching devices, rare mathematical books, portraits of famous mathematicians, etc., in the museum of Teachers College, greatly added to the interest of the occasion.

The next meeting of the association will be held at Columbia University, New York City, about Easter time, and applications for membership and other communications may be addressed to Arthur Schultze, secretary, No. 4 West 81st Street, New York City.

In addition to the officers, the following were elected as council of the association: Professor John S. French, Jacob Tome Institute, Port Deposit, Md.; A. M. Curtis, State Normal School, Oneonta, N. Y.; Harry English, Director of Mathematics, Washington high schools, Washington, D. C.; John R. Gardner, Irving School, New York City; W. Z. Morrison, Shadyside Academy, Pittsburgh, Pa.; Mary V. Shea, Commercial High School for Girls, Philadelphia, Pa.

SHORTER ARTICLES.

THE PELÉ OBELISK.

The most remarkable phase of the still continuing eruption of Monte Pelé is the appearance on the summit of the mountain of a column of solid rock which is a conspicuous feature even when seen from a distance of fifty or more miles. The nature of this 'obelisk,' the changes it has undergone, its rate of ascent, etc., have been faithfully reported by Professor A. Lecroix, Professor Angelo Heilprin, Major W. M. Hodder, Dr. E. O. Hovey and others,* but a more comprehensive statement than I believe has yet appeared in print, as to the place to be assigned it in the sequence of events normal to volcanoes, may be of interest to the general reader.

The earlier of the recent eruptions of Monte Pelé and all of those of La Soufrière of St. Vincent since early in May, 1902, as will be remembered, were explosive. Neither volcano has as yet discharged a stream of liquid lava. During the explosive eruptions referred to, vast quantities of angular rock-fragments were blown into the air, and fell on the adjacent land and sea. The material thus showered on Martinique and St. Vincent consists for the most part of fresh lava, but contains also large quantities of fragments of rock of older date, which were torn from the inner walls of the conduits through which the explosive discharges took place, and in addition on the sides of each volcano there are many 'bread-crust bombs' as they are termed, or masses of lava frequently two feet or more in diameter, that were blown out of the craters in a plastic condition and assumed rudely spherical forms during their aerial flights. A large portion of the fragmental material, but more especially that composed of fresh lava, is in the condition of fine dust-like particles.

The nature and explanation of the explosions referred to may be readily appreciated by picturing in fancy, as may be done from the evidence in hand, the sequence of events during the eruptions.

A volcano, it will be remembered, is a tube or *conduit* leading from the earth's surface sufficiently deep into its interior to reach a region of intense heat. In the case of the Antillean volcanoes under consideration, the conduits may be considered as rudely circular in cross section and approximating five or six hundred feet in diameter, and of great but unknown depth. Through the conduits rock material so hot that it was molten or rather as is more probable, because of the great pressure present, in a plastic and viscous condition, or a *magma,* as it is convenient to term it, was forced upward from a depth and reached or made a near approach to the bottoms of the craters from which the products of the explosions were blown out. The magma

* Science, November 13, 1903, Vol. XVII., pp. 633–634. *American Journal of Science*, October, 1903, Vol. XVI., pp. 269–281.

as it rose lost some of its heat, principally on account of the cooling effect of the water which gained access to it, and as it approached the summit of the mountain, changed to a solid and rigid condition. Steam explosions occurred in the congealed portion, of such intensity that it was shattered, much of it being reduced to dust, and the fragments produced blown heavenward. During the greatest of the explosions the projected fragments were hurled to a height of four or five miles.

In the manner briefly outlined above, the rigid summit portion of the rising columns within the craters of the volcanoes was removed and fresh material was forced upward from a depth to take its place, and the process repeated. There was thus a transfer of material from deep within the earth to its surface just as truly as if an overflow of molten rock had occurred. In fact the material blown out by Pelé or by La Soufrière would in each instance, if melted and run together, form an extensive lava flow, or one, I venture to say, exceeding in volume all of the lava discharged by Vesuvius during the eruptions of 1872.

The eruptions thus far considered may be termed fragmental-solid discharges, except that on both Martinique and St. Vincent a minor portion of the material extruded was in a plastic condition when blown into the air. This still plastic material probably came to the surface during the later stages of several of the eruptions which furnished the solid angular fragments.

La Soufrière has exhibited only the explosive phase of solid eruptions, but Monte Pelé has undergone another and much more novel variation of the same process. Succeeding the earlier and more intense explosions in the summit portion of the conduit of the volcano on Martinique, the solid lava in its throat was forced upward in a massive condition until, in spite of many losses, it stood at one time about 1,600 feet higher than the rim of the crater from within which it was protruded. Its rate of ascent for a period of eighteen days, as observed by Major Hodder, was forty-one feet per day. The massive tapering column, or 'obelisk,' was approximately 600 feet in diameter near its base, and composed of solid or massive rock, and not of angular fragments or adhering cinder-like scoria, as in ordinary cones of eruption. Light was emitted from fissures in its sides, and steam escaping from it showed also that its interior was still hot. The fall of material from the summit and sides of the obelisk and at times its nearly complete destruction, may be accounted for by its structural weakness and by the occurrence of steam explosions owing to rain-water gaining access through fissures to its hot interior. A still more important agency leading to its diminution appears to have been furnished by steam explosions about its base. Then, too, as will be understood, a huge irregular plug of solid rock was being pushed out by pressure applied beneath, through an irregular opening in still more rigid rock, and many jars and tremors must have occurred which would tend to dislodge masses of material from the sides and summit of the ascending plug. Allowing for the losses due to these various causes, the elevation which the obelisk would have attained, had it suffered no loss in height, can reasonably be estimated at not less than three thousand feet.

The obelisk is evidence that the upward movement of the material in the conduit beneath it did not cease when explosions in its rigid summit portion failed to remove material as fast as it rose from a depth, but continued and was the cause of the forcing out of the summit of the plug in the manner described.

As the rock composing the obelisk was still hot even after rising high in the air, the decrease in the energy of the explosions which accompanied its growth can not be ascribed to the lack of the necessary heat to vaporize water. The only other alternative seems to be that the rate at which water gained access to the summit portion of the volcano's conduit diminished, or there was a marked decrease in the vapor content the rising magma brought from a depth.

Thus far, as may reasonably be claimed, the conclusions reached are a direct and legitimate deduction from the facts observed. We

can take still another step, but with less confidence, in the same direction.

In reference to the proximate source of the water which changed to steam, which is a conspicuous accompaniment of all volcanic eruptions, there are two leading hypotheses; one, to the effect that it is derived mainly from a deep source and was present in a state of solid solution in the magmas supplied to volcanoes before their migration outward from the earth's interior, and, also, that the steam thus occluded, or its component gases, is expelled as loss of heat occurs and the magmas change from a liquid or a plastic to a solid condition; and the other, that water descends from the earth's surface and meets the ascending magmas and becomes occluded in them and at the same time decreases their temperature.

To be sure, both of these hypotheses may be true, and both of the processes referred to be in action at the same time; but even if such were the case, it is to be presumed that one source of water supply or the other would be dominant and in control.

One of the most interesting questions in connection with the obelisk of Pelé is in reference to the evidence it furnishes favoring one or the other of the hypotheses referred to.

If the steam given off by the volcano was an original or primary constituent of the magma which rose in its conduit, it is reasonable to suppose that the distribution of vapor or gases in the magma before its upward migration would be essentially uniform in all parts of the 'reservoir' from which it was supplied. This assumption, as must be freely admitted, is not susceptible of direct proof, but the little which is known concerning the diffusion of gases in liquids seems to demand that the tension in all parts of a relatively restricted mass of the magma in the subcrustal portion of the earth shall be the same. It may be argued that such a conclusion is not permissible in view of our almost total ignorance of the condition of matter under the influence of pressures and temperatures such as exist at a depth in the earth, but as the volcanic problem now stands, it certainly does not seem reasonable to suppose that there can be any conspicuous variations from place to place in the primary vapor content of the magma which supplies a single volcano. That is, we have no reason for concluding that the material which was forced upward in the conduit of Monte Pelé, while yet deep in the earth, was in a pronounced degree vapor-charged in one part more than another, and can not appeal to such a supposed variation to account for the diminution in the energy of the explosions in the summit portion of the conduit, or the accompanying change in the material extruded from a fragmental to a massive-solid condition.

Under the hypothesis that the steam given off by volcanoes has its chief source in the water supplied by downward percolation, or descends from the earth's surface through fissures, etc., and meets an ascending magma, the rate of such supply may reasonably be considered as variable and its depletion possible in case great demands are made upon it.

How surface water is enabled to reach a volcano's conduit, and the methods by which it is absorbed or passes into a state of solid solution, are again obscure, but these questions may well be left in abeyance, during the search for evidence as to the source or sources from which the water is derived.

In the instance before us, the evidence seems to show that the earlier explosions exhausted, or at least greatly depleted, the water within reach of the volcano's conduit, and in consequence the conspicuously violent eruptions ceased and the rigid although still hot plug of lava in its summit portion was forced upward by pressure beneath its base and rose far above the rim of its encircling crater. In this connection also it may be noted that the access of water to the summit portion of the conduit of the volcano seems essential to account for the observed cooling and hardening of the rising magma at that locality; on the other hand, the fact that the rigid lava was not shattered and blown to fragments suggests that water in considerable quantity did not gain access to it. In reference to these and many other questions bearing on the theory of volcanoes, the reports of the detailed observations that are being made on

the behavior of Pelé by the French commission, will be looked for with interest.

Israel C. Russell.

CURRENT NOTES ON METEOROLOGY.

METEOROLOGICAL BIBLIOGRAPHIES.

It is likely that but few persons will be perfectly satisfied with any single volume of the 'International Catalogue of Scientific Literature,' but the help to be gained from the different volumes is so great that it seems rather ungrateful to make adverse comments. Any one who has endeavored to keep a complete card catalogue of the current literature in even one science will necessarily appreciate these volumes much more fully than he who has not spent many weary hours in the monotonous labor of copying titles from scientific journals. The writer has, since 1887, the date with which the 'Signal Service Bibliography of Meteorology' ended, kept for his own use, and that of his students, a fairly complete card catalogue of meteorological literature, not only of original articles, but also of notes, abstracts and reviews. To him, therefore, the publication of the 'International Catalogue,' unsatisfactory as it is in many respects, means the relief from cataloguing to which reference has just been made, and this means the addition of just so many more hours to constructive work.

The chief complaint which is to be made regarding the first volume on meteorology (1901) of the 'International Catalogue' is the entire omission of the *Meteorologische Zeitschrift*. The *Zeitschrift* is by far the most important of all meteorological journals, and no one can pretend to keep up with the progress of the science who does not see this publication regularly. It is evident, moreover, that Austrian publications as a whole were neglected, for we miss also the *Sitzungsberichte* and the *Denkschriften der Wiener Akademie der Wissenschaften*, which have always contained valuable contributions to meteorology. Furthermore, Dr. Hann, whose writings on meteorology are among the most important the world over, and who by common consent stands in the very front rank of meteorologists and climatologists, appears in this volume only as the author of the 'Lehrbuch der Meteorologie' and of one article, of comparatively little note, published in the *Geographische Zeitschrift*. It is almost inconceivable that this volume should have been allowed to appear without any mention of the *Zeitschrift* and of the Vienna Academy publications. Doubtless the mistake will be rectified in the 1902 issue, and it certainly should be.

There are a number of misprints. Among them we have noted the spelling of Dr. Köppen's name as Koppen; of *Meteorologie* as *Meterologie*, etc. Nevertheless, with all its imperfections—and we do not propose to debate here the question of the classification which has been adopted by the International Council—the 1901 volume on meteorology of the catalogue will be received by many workers in meteorology, as it has been by the writer, with a grateful feeling of relief.

While considering meteorological bibliographies, it is to be hoped that an appropriation from the Carnegie fund may be made with a view to completing and printing the 'Signal Service Bibliography' above alluded to. The few copies of that publication which were sent out, in the very crude form which was alone possible at the time of its issue, but emphasized the importance of the work. It would be a very great help to meteorologists and other persons who have need to refer to meteorological literature, if the 'Signal Service Bibliography' could at last be completed and properly printed.

As regards current meteorological bibliographies, these are now published regularly in three journals, the *Meteorologische Zeitschrift*, the *Monthly Weather Review* and the *Quarterly Journal of the Royal Meteorological Society*. With these lists coming in from month to month, and with the annual list in the 'International Catalogue,' the lot of working meteorologists and climatologists, as well as of teachers and students of these branches of science, is made much easier than it was a year or so ago.

R. DeC. Ward.

BOTANICAL NOTES.

ANOTHER FERN BOOK.

Under the simple title of 'Ferns' Dr. C. E. Waters, of Baltimore, has added another book of 362 large octavo pages to the quite creditable list of popular treatises on the ferns of the northeastern United States, and it has been given fitting form by the publishers, Holt and Company, of New York City. The work is intended for amateurs, and is in fact a popular manual based on analytical keys which can be used for the identification of ferns whether fruiting or not. This is accomplished by having, in addition to the usual key based on the fructification, another which makes use of characters derived from the stalks alone. In this the number and shape of the fibrovascular bundles are of primary importance, but to these are added other characters, as the size, color, ridges, grooves, etc., of the surface of the stalks. For the bundle characters good diagrams are used, and throughout the work there are about two hundred admirable 'half-tone' reproductions of photographs, which must prove very helpful to the student, whether amateur or professional. The keys refer to fuller descriptions of each species, and these are all that one could wish in a book of this kind. There is first a short, somewhat technical description (in smaller type), and this is followed by a popular account which runs on with a charming freedom from conventionality. There is no attempt to treat every species in the same manner; on the contrary, the author seems purposely to have varied his treatment, often making an apt quotation of a stanza or two from some poem.

The nomenclature is nearly that of a decade or two ago, but modern synonyms are given sufficiently to make the book usable by those who have access only to very recent manuals. It is of little moment in a book of this kind what nomenclature is used, and for this reason the omission of the authority for the species is of no consequence. It is sufficient to say that the author knows ferns so well that his pronouncement may well be accepted by all amateur students of the ferns. The book should have a wide circulation among the large number of people who love ferns and want to know something about them. It will also be found to be a very useful book in the library of the professional botanist.

ST. LOUIS AND THE BOTANISTS.

In a few weeks the botanists of the country will have the opportunity of visiting St. Louis in order to attend the meetings of the botanical section (G) of the American Association for the Advancement of Science, and the affiliated societies. The botanical attractions are unusually great in St. Louis. The Missouri Botanical Garden, with its wealth of living plants in the extensive hothouses, and the out-of-door plantations covering many acres of ground, will interest every botanist who visits it. Then there is the garden herbarium, one of the largest in America, and very rich in type specimens, and also the collections of botanical works constituting the large garden library. Here are the specimens and books which Dr. George Engelmann studied and used, and here are the rooms and buildings in which he worked. To the younger generation of botanists these associations should be unusually attractive, for it is helpful to see where and with what means those who preceded us have done their work. There should be a full attendance of botanists at these meetings.

THE ECONOMIC PLANTS OF PORTO RICO.

Several years ago O. F. Cook and G. N. Collins were sent by the United States Department of Agriculture to Porto Rico to make investigations in regard to the agriculture of the island. One result of their work has been the preparation of a thick pamphlet of somewhat more than two hundred octavo pages consisting of an annotated list of Porto Rican plants of economic importance. It appears as one of the 'Contributions from the United States National Herbarium' (Vol. VIII., part 2), under the supervision of the curator of botany, Mr. F. V. Coville.

In the short introduction reference is made to the books on the plants of the island, in which the authors say that "the botany of Porto Rico is far from complete, and very

little of it has been written in the English language. * * * But two authors have attempted a connected sketch of the Porto Rican flora, and the efforts of these not only remain incomplete in that they do not cover the entire series of families of flowering plants, but the lists are also partial and local, as the writers themselves realized. The first of these sketches was that of Don Domingo Bello y Espinosa ('Apuntes para la flora de Puerto-Rico,' 1881–1883). * * * The second of these sketches and the most important contribution to the botany of Porto Rico is the Flora projected by Dr. A. Stahl, of Bayamon, but unfortunately only partially published ('Estudios para la flora de Puerto-Rico,' 1884–1888). * * * In spite of public indifference and official animosity six parts of the flora were issued at the expense of the author, having been prepared in the intervals of his professional life as a physician. Publication ceased in 1888, and Dr. Stahl no longer hopes to continue the work." Two other titles are given, viz., 'Diccionario botanico de los nombres vulgares cubanos y Puerto-Riquenos,' by Manuel Gomez de la Maza, and 'El medico botanico criollo,' by Rene de Grosourdy.

The catalogue proper consists of an alphabetical list of names, common and scientific, with descriptive notes and cross references. Here the reader finds many interesting facts about tropical and semitropical plants which are or might be grown in Porto Rico and other West Indian islands. One is struck, after reading a few pages, with the fact that there is much to be done on this island possession of ours in order to develop its use of the plants which may be grown there with profit. Coffee appears to be the most important of the cultivated plants, and yet we learn that "the most careless and wasteful methods are practised in the culture of this important crop. No attention is paid to the selection of seedlings, most of the new plants being secured from seeds that have germinated under the trees in the old plantations. It is estimated that by proper methods of cultivation the yield from the land now devoted to coffee could be doubled or tripled." Similar statements are made with reference to most of the crops of the island. Evidently there is a field of work here for the United States Department of Agriculture, and this volume is an indication that it is entering upon it with energy and ability.

Charles E. Bessey.

The University of Nebraska.

THE CARNEGIE INSTITUTION.

The newspaper reports in regard to the second annual meeting of the trustees of the Carnegie Institution, held in Washington on December 9, read as follows:

"There were two sessions, with a dinner following. The report submitted on the proceedings of the last year was supplemented by explanatory statements by Dr. Gilman, the president of the institution, and by Dr. Walcott, the secretary. The report on the year's operations showed sixty-six grants made by the executive committee for scientific research, involving an aggregate of \$150,000, and recipients representing every part of the United States and the smaller colleges as well as the large universities, observatories and laboratories. Twenty-five research assistants were appointed. These sums are exclusive of administrative and incidental expenses of the institution. The beneficiaries are given the option of making public the nature of these grants. Action on request for 1,022 grants, involving an allowance of \$3,000,000 a year, was indefinitely postponed. Arrangements have been made for publication at an early day of eleven scientific papers, most of them making large and costly volumes. Among the subjects now under consideration by the institution in connection with grants are a solar observatory; southern observatory; geophysical laboratory; Transcaspian exploration and archeological exploration; exploration in the south Pacific, establishment of biological experiment laboratories and international magnetic researches.

"The morning session was devoted mostly to a discussion of several large projects. No conclusion was announced. The trustees authorized an aggregate expenditure of \$373,000 in grants for scientific researches and \$40,000 for publications during the ensuing year.

"It is said that Mr. Carnegie made a brief address, in which he commended the work already done and talked of the aim of the institution to give liberal encouragement, in cooperation with other institutions, to investigation, research and discovery; to provide buildings, laboratories,

books and apparatus and afford advanced instruction to qualified students.

"The following officers of the Board of Trustees were elected:

Chairman—John S. Billings, New York; Vice-Chairman—Elihu Root, secretary of war; Secretary—Charles D. Walcott, director of the geological survey.

Vacancies on the board were filled by the election of John Cadwalader of New York to succeed Abram S. Hewitt, deceased; Cleveland E. Dodge, New York, to succeed William E. Dodge, deceased, and Judge William Wirt Howe, New Orleans, to succeed Justice Edward D. White, resigned.

Secretary of State John Hay was chosen as a member of the executive committee in the class of 1905 to succeed Mr. Hewitt and Dr. S. Weir Mitchell and Carroll D. Wright were reelected for three years as members of the executive committee.

"President D. C. Gilman will resign his office one year hence. For some time rumors have been current that Dr. Gilman would retire during the present meeting, and when it was known that he and Mr. Carnegie had had a long private conference it was assumed that the matter was settled. A letter from Dr. Gilman to the trustees, however, showed that he did not intend to make any sudden move. His letter reminded his colleagues that the fixed term of the presidency of the institution was five years, of which he had now served two; that his increasing age made the labors of an executive at the head of so great an establishment very onerous, and that he did not feel that he could continue to bear the burdens beyond the next year, when he should expect the acceptance of his resignation."

HENRY CARRINGTON BOLTON.

At a meeting called by the Washington Chemical Society, held in Columbian University, on Monday evening, November 25, in honor of the memory of the late Henry Carrington Bolton, addresses were made by the president of the society, Dr. F. K. Cameron, Dr. Chas. E. Munroe, Dr. H. W. Wiley, Dr. F. W. Clarke, Dr. Marcus Benjamin and Professor R. B. Warder. A committee consisting of Drs. Munroe, Clarke and Wiley was appointed with power to formally express the sorrow of the members of the society for the bereavement which they had suffered. Following is the memorial prepared by the committee:

"Death has suddenly removed from earth our friend and coworker, Dr. Henry Carrington Bolton. In his death chemistry has lost a disciple, who gave to her service the enthusiasm of his youth, the strength of his manhood and the wise council of his riper years.

"Our section has lost a member who through his experimental researches and especially by his notable additions to bibliography has contributed much to the advancement of the science which it is the purpose of this society to promote. These distinguished services to science have placed all who are interested in chemistry under lasting obligations.

"The student of chemistry has lost a friend who was always ready to extend the right hand of fellowship and to contribute freely from his rare store of knowledge and extended experience.

"The community has lost a man who by his genial qualities, his high ideals, his faithfulness to the duties he undertook, his catholicity of views and of interests and his tolerance of the opinions of others endeared him to all who knew him.

"His life was a benefaction, his presence always a blessing and his career one of usefulness to man.

"We ask that this tribute to his memory be spread upon the minutes of the society; that it be printed in the proceedings and in Science and that an engrossed copy be presented to Mrs. Bolton.

"On behalf of the society,

"Chas. E. Munroe,
"F. W. Clarke,
"H. W. Wiley."

SCIENTIFIC NOTES AND NEWS.

The Royal Society held its anniversary meeting on November 30, when the officers were elected whose names have already been printed in this journal. A contest took place for the post of general secretary, vacant by the resignation of Sir Michael Foster, for which Sir Archibald Geikie was nominated by

the council and Professor W. D. Halliburton by a considerable number of independent fellows, and the former was elected by a large majority. The president, Sir William Huggins, gave the usual address reviewing the activities of the society during the past year. At the banquet in the evening addresses were made by the president, Lord Robertson, Professor Curie, Lord Alverstone, Sir Arthur Rücker, Sir Michael Foster and Sir Archibald Geikie.

PROFESSOR KUNO FISCHER, now in his eightieth year, has retired from active duty as professor of philosophy in the University of Heidelberg.

PROFESSOR H. E. GREGORY, of Yale University, has begun work on a geological map of Connecticut, as provided for in a recent act of the state legislature.

PROFESSOR W. B. SCOTT, of Princeton University, lectured before the Teachers' Institute of Cooper Union on Tuesday evening, December 8, the subject being 'The Topography of Sedimentary Rocks.'

PROFESSOR SEELEY'S course of eight lectures on 'The Fossil Reptiles of South Africa' is now being given in the Geological Laboratory, King's College, on alternate Tuesdays at 4:30 P.M.

A NEW division, that of Forest Products, has been organized in the Bureau of Forestry with Dr. H. von Schrenck in charge.

MR. J. MORGAN CLEMENTS has resigned his position at the University of Wisconsin and the U. S. Geological Survey to engage in professional work in New York City.

A PRESENTATION and banquet were given on November 21 to Dr. Cunningham by his Dublin colleagues and friends, to mark their regret for his departure to Edinburgh and their appreciation of his work while professor of anatomy in Dublin University. His successor, Professor A. F. Dixon, presided.

THE American Scenic and Historic Preservation Society held, on December 9, a meeting in memory of the late Andrew H. Green at the American Museum of Natural History.

THE widow of the late Professor Virchow has given about 7,000 volumes from his library to the Berlin Medical Society.

As a matter of record, we note the death of Mr. Herbert Spencer, in his eighty-fourth year, which occurred at Brighton on December 8.

SIR FREDERICK BRAMWELL, the eminent engineer, died in London on November 30, at the age of eighty-five years. He was elected a fellow of the Royal Society in 1873; president of the Institution of Mechanical Engineers in 1874; president of the Institution of Civil Engineers in 1884, and president of the British Association for the Advancement of Science in 1888.

FOR the accommodation of delegates and members of the American Association for the Advancement of Science from New York, Philadelphia, Baltimore, Washington and cities tributary thereto to the meetings to be held in St. Louis from December 26 to January 2, the Baltimore and Ohio Railroad will run a special train composed of Pullman sleepers and dining car, leaving New York at 10:30 A.M., Philadelphia 12:48, Baltimore 3:00 and Washington 4:15 P.M., December 26, arriving at St. Louis at 5:25 P.M., December 27. For full information and seat reservations apply to Lyman McCarty, assistant general passenger agent, Baltimore and Ohio Railroad, 434 Broadway, New York, N. Y.

THE Geographical Society of Philadelphia has in press and will shortly issue Commander Peary's report on arctic explorations conducted under the auspices of the Peary Arctic Club of New York, and covering a period of five years. At the meeting of the society on December 2, an address was delivered by Dr. Frederick A. Cook, of Brooklyn, on his recent researches in the McKinley range of Alaska and the attempted, but not successful, ascent of the loftiest summit of the North American continent. The official report of these researches will also be published by the Philadelphia Society.

THE executive board of the Association for maintaining the American women's table at the Zoological Station at Naples and for promoting scientific research by women an-

nounces that applications for the Naples table for the year 1904 should be sent to the secretary, Miss Cornelia M. Clapp, Mount Holyoke College, South Hadley, Mass. During the past five years eight women have been appointed by the association, seven of whom have received the title of 'scholar.' Through the special kindness of Dr. Dohrn, two may be received at the station at the same time, both having placed at their disposal equal opportunities for work.

The New York Aquarium will hereafter use for its salt-water tank the closed circulation system, the water being brought from the sea and kept in a reservoir of 100,000 gallons. After the water is used it is filtered and aerated and returned to the reservoir. Hitherto the water has been taken from the bay, where it varies in density and purity.

Transit-room shutters of a new design by Professor D. P. Todd were erected the last week in November at Amherst College Observatory. They were built by the Coburn Trolley Track Company and the Norton Iron Works, with special reference to ease and rapidity of working.

UNIVERSITY AND EDUCATIONAL NEWS.

By the will of William Wyman, of Baltimore, the Johns Hopkins University may expect ultimately to receive the residue of his estate, valued at $500,000.

By the will of Henry S. Nourse, of Lancaster, Mass., a fund is set aside for Harvard University which will amount to at least $50,000.

Columbia University has received a gift of $5,000 from Mrs. Butler, of New York, to found a scholarship; an anonymous gift of $10,000 is also announced.

It appears that the will of the late Gordon McKay, leaving a very large sum for scientific work at Harvard University, will be contested by a distant relative.

The University of Aberdeen has received from the trustees of the late Mr. John Reid, of Shannaburn, a sum that will provide not less than $2,000 a year for post-graduate research scholarships.

The University of Wales has received by the will of the late Mr. Price Davies, of Leeds, the sum of about $35,000 for scholarships.

Sir William MacDonald has given $2,000 to McGill University for experimental work in physics.

A school in biology will be conducted at Coronado Beach during the Christmas vacation, under the auspices of the University of California. The work will be directed by Professors W. E. Ritter and C. A. Kofoid.

Principal Peterson, of McGill University, after a conference with Sir Thomas Shaughnessy, president of the Canadian Pacific Railway, has announced that a railway department will be created in connection with the university.

At an educational meeting held at the University of Chicago on November 15 and attended by more than two hundred superintendents of high schools and academies of the middle west, it was unanimously resolved that the first two years of college work should be added to the curriculum of high schools and academies.

It is reported that Dr. Charles W. Dabney, president of the University of Tennessee, has been offered the presidency of the University of Cincinnati.

Dr. Thomas Hunt Morgan, now professor of biology at Bryn Mawr College, has been elected professor of experimental zoology in Columbia University.

Professor Hugo Münsterberg, of Harvard University, has been elected non-resident lecturer on psychology at Columbia University, where he will give a special course of lectures in the early spring.

Professor F. G. Wrenn has been elected Walker Professor of Mathematics in Tufts College in the room of the late Benjamin F. Brown.

Mr. T. H. Havelock, fifteenth wrangler in 1900, Smith's prizeman in 1901 and Isaac Newton student in 1902, has been elected fellow of St. John's College, Cambridge.

SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, DECEMBER 25, 1903.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

GRANTS MADE BY THE CARNEGIE INSTITUTION.

AT the last annual meeting the trustees set apart $200,000 for grants for research during the fiscal year 1902–3. The following is a list of grants made by the executive committee under such authority. Each one is accompanied by a brief statement of the results thus far obtained. When an investigation is completed, a final report will be submitted by the grantee. This may be printed either in abstract or in full in the 'Year Book.'

ANTHROPOLOGY.

G. A. DORSEY, Field Columbian Museum, Chicago, Ill. *For ethnological investigation among the Pawnees.* $2,500.

Abstract of Report.—This scheme of investigation will require four or five years for its completion. It is a study of the religious ceremonies of the Pawnee Indians, with direct reference to the mythological origin of each ceremony, and to obtaining a clear and comprehensive understanding of the religious systems of the Pawnees.

The work of collecting and arranging the details of the region of the religion was begun early in the year, and has been pushed forward as rapidly as possible. The work of the first year was to obtain the mythology of the Skidi on the one hand, and the Chaui, Kitkahahki and Pittahauirata bands of Pawnees on the other, and of the Wichita and Arikara. The second re-

sult sought for was to gain a comprehensive insight into all the ceremonies of the four bands of the Pawnees and of the Arikara. Of these two results as much has been achieved as could be hoped for, inasmuch as the work has progressed for only about nine months.

With the beginning of the first of the Skidi ceremonies early next spring, it will be possible to select certain of the more important ones for more detailed observations. Thereafter each ceremony will be studied independently and in detail, and the observations thus made, together with the ritual as sung, will be prepared for publication.

Wm. H. Holmes, Director Bureau of American Ethnology, Washington, D. C. *For obtaining evidence relative to the early history of man in America.* $2,000.

The phenomena to be considered are scattered and obscure. The geological formations of both continents, ranging from Eocene to Recent, abound in various records, but investigation has been in the main desultory and unscientific, and the isolated observations are to-day without adequate correlation.

Mr. Holmes proposed to begin his work with the compilation of all data respecting previous investigations, and then to begin field work which should extend to deposits in caves and caverns where men have lived, and should also include their ancient sites, such as kitchenmiddens, shell heaps, and earthworks.

Abstract of Report.—The field work in this investigation was done mainly by Mr. Gerard Fowke, archeologist, who began work in Indiana and carried his examinations into Illinois, Kentucky, Tennessee and Alabama, exploiting many caves and making careful investigation of a few. Results were distinctly negative with reference to the principal question at issue, the entire season's work having developed no fact that will tend to establish a theory of the great antiquity of man in America. The season's work, however, was not a failure on this account, since the question is one that must be solved, if not by the discovery of positive evidence, by establishing the universality of negative evidence.

Late in the season explorations were begun on the Atlantic slope by Mr. F. B. McGuire, archeologist, in the caves of the upper Potomac in West Virginia. Mr. Holmes personally made a reconnaissance in Georgia and Alabama for the purpose of collecting definite information regarding the caves of the south.

With the aid of Mr. F. B. McGuire and Dr. J. W. Fewkes, a cave in Porto Rico was explored without expense to the Institution. The present report can be regarded as only one of progress, since Dr. Fewkes and Mr. McGuire are still in the field.

George F. Kunz, New York City. *To investigate the precious stones and minerals used in ancient Babylonia in connection with the investigation of Mr. William Hayes Ward.* $500.

Abstract of Report.—This is an investigation in cooperation with that of Mr. William Hayes Ward. It was deferred until winter in order to secure the cooperation of Mr. Ward after his return from his investigations in Europe.

William Hayes Ward, New York City. *For study of oriental art recorded on seals, etc., from western Asia.* $1,500.

Dr. Ward has been for fifteen years devoting his spare time to oriental archeology, with special reference to the beginnings of art and mythology, as shown in recovered monuments and especially in the seal cylinders, which preserve a large part of the early art. He has handled thousands of seals and has paper impressions of thousands. The investigation covers a period

from about 4000 B. C. to about 400 A. D. and will include a study of the mythological representations and various designs, emblems and inscriptions contained in them.

Abstract of Report.—During last summer Dr. Ward has visited various museums in the United States and in Europe, where he examined the great collections of Paris and Berlin. Every facility was granted by the authorities in charge, and he made notes and obtained casts of such cylinders and seals as were required for his investigations. He is now engaged in the preparation of manuscript and illustrations. It is estimated that it will require about two years to complete the study and prepare the results for publication.

ASTRONOMY.

Lewis Boss, Dudley Observatory, Albany, N. Y. *For astronomical observations and computations.* $5,000.

Abstract of Report.—This work has for its ultimate object an investigation upon the motions of the brighter stars (all down to the seventh magnitude), and of all stars, of whatever magnitude, supposed to have motions as great as 10″ per century, and of many other stars which were specially well determined prior to 1850.

During the year Professor Boss's attention was given to—

(*a*) The compilation for each star of all observations for position that have been made upon it during the history of astronomy. Some stars are found in more than sixty catalogues.

(*b*) Investigation of the systematic errors with which each series of meridian observations seems to be affected, in order that the precision of the results may be notably increased. This involves in the first place the establishment of a standard of reference, which must include the positions of all those stars which have been most frequently and accurately observed.

The entire work is proceeding upon a logical plan carefully studied and formulated through the results of experience during past years, with a view to economy in the succession of individual investigations designed to contribute to the final result. In an extensive investigation of this kind there is always an element of danger. If the work is so planned that definite results can not be realized until the completion of the whole work, there is liability to serious loss from the ordinary accidents of life which can not be foreseen. Therefore this work has been so planned that useful results can be secured and promptly published at every successive stage of the work. Each step grows logically out of those which have preceded it. The computations are so planned that successive improvements in the fundamental basis can be introduced with the least possible duplication of work.

It is intended that the catalogue of more than 2,500 standard stars shall be offered for publication to the Carnegie Institution early in 1905, and if no unforeseen accidents occur this program should be entirely feasible.

During the present year the catalogue of 627 standard stars has been passing through the press and is now nearly ready for issue. Subsidiary investigations connected with this catalogue have been carried out under the grant of the institution for this year.

Boss, Hale and Campbell. *For investigating proposal for a southern and a solar observatory.* $5,000.

In the Year Book for 1902 a proposition for the establishment of a distinctly solar observatory was presented by Professor S. P. Langley. In the same report (page 89) the astronomical advisers called attention to the lack of observatories in the southern hemisphere, and in an appendix (pages 99

to 104) they treated the subject still more fully.

In order that the board of trustees might be enabled to arrive at appropriate conclusions, Professor Lewis Boss, chairman; Professor George E. Hale and Professor W. W. Campbell were requested to investigate, as a committee, the subject more fully and to consider the question of suitable sites for such observatories.

The result of the work of this committee is submitted in the 'Year Book.'

W. W. Campbell, Lick Observatory, Mt. Hamilton, Cal. *For pay of assistants to take part in researches at the Lick Observatory.* $4,000.

Abstract of Report.—Owing to the difficulty of obtaining satisfactory assistants from the east and providing living quarters for them on the mountain, it was not found possible to provide for an effective use of the grant for the employment of assistants and computers until late in the year. Investigations were begun with the meridian circle work and in spectroscopy. With the construction of additional residence quarters on the mountain, Professor Campbell will soon employ the full number of assistants rendered possible by the grant.

Herman S. Davis, Gaithersburg, Md. *For a new reduction of Piazzi's star observations.* $500.

American and European astronomers have urged that a fresh reduction of these observations by known methods for obviating certain errors should be made. Professor Porro, of Turin, undertook a part of the reductions and Professor Davis the rest. Assistance from private persons and from observatories has contributed to the prosecution of this undertaking. The Carnegie Institution was asked to make a small contribution.

Abstract of Report.—The work accomplished under this grant has been in connection with work that was already begun. This makes it difficult to define specifically the exact amount done under the grant from the Carnegie Institution. The period of nine months, during which the grant has been available, has marked the transition from the routine work of reducing the observed 'apparent' positions of the stars to a common 'mean' epoch to the next large step of deducing therefrom the instrumental errors and compiling the final catalogue. This rendered it necessary to spend this time in rounding out and perfecting all the divers portions of the computations which have been going on uninterruptedly for the past seven years. This has been finished, and also some preliminary work done for the next great and distinct stage of the work: (*a*) To deduce the errors of the telescope for each night of observation; (*b*) to correct all observations for these maladjustments, and (*c*) finally, to combine the definite separate positions into means for each star included in the catalogue, which is the goal of the long labor.

George E. Hale, Yerkes Observatory, Williams Bay, Wis. *For measurements of stellar parallaxes, solar photographs, etc.* $4,000.

Abstract of Report.—Work was begun on the photographic investigation of stellar parallaxes early in May with a forty-inch telescope. Up to October, 114 plates, containing about 350 exposures, had been obtained. These included: (*a*) Twenty experimental plates, (*b*) eighty-eight plates suitable for parallax determinations, and (*c*) six plates of loose star clusters.

Considerable work was also done in the measurement of photographs of star clusters.

Another line of investigation was the photometric determination of stellar magnitudes. Considerable progress was made in this, fields being measured with the six-

inch reflectors and the twelve- and forty-inch refractors. Measures were also made upon the Pleiades group of stars to determine the constant of the equalizing wedge photometer. Measurements were also made of comparison stars for faint variables.

Much progress was also made in the measurement and discussion of photographs of the sun, taken with the spectroheliograph at the Kenwood Observatory in the years 1892–6, and in other minor investigations connected with the work in hand.

SIMON NEWCOMB, Washington, D. C. *For determining the elements of the moon's motion and testing the law of gravity.* $3,000.

Much of the material for this investigation, consisting of computations of places of the moon from Hansen's tables and their comparison with observations, was preserved in the archives of the Nautical Almanac Office, awaiting an opportunity for their working up. By permission of the Secretary of the Navy, Hon. William H. Moody, these papers were entrusted to the Carnegie Institution and by the Institution to Professor Newcomb.

Abstract of Report.—The importance of this work grows out of the fact that new tables of the moon are urgently required for the purposes of astronomy and of navigation. For a long period the problem of constructing and perfecting such tables has been delayed by an unexplained discordance between the observed motion of the moon and the motion which should result from the action of all known bodies upon it. The exact cause of this discordance can not be recorded, because the observations from 1750 to 1850 have never been worked up and compared with the tables. The problem of determining the exact nature of the deviation of the moon from its predicted place is twofold. The observations since 1750 must be worked up, and in order to compute the comparison the action of the planets on the moon must be recomputed with a view to determining whether any correction to the past computations is necessary.

By aid of a grant from the Carnegie Institution an important term of long period, produced by the action of Venus, has been recomputed.

Professor Newcomb has taken up the work on the adopted plan of the occultations of stars by the moon, a work that he had begun in connection with the Nautical Almanac. This, in connection with the incorporation of other important observations, can probably be completed in two years more.

E. C. PICKERING, Harvard University, Cambridge, Mass. *For study of the astronomical photographs in the collection of Harvard University.* $2,500.

Abstract of Report.—The grant made to Professor Pickering was applied to a great variety of uses. These included sums paid to nineteen different assistants and computers, and for other assistance in connection with the Harvard Observatory.

Each of the numerous investigations is of importance in carrying forward the work going on in the observatory, but they do not appear to be upon sufficiently definite and specific problems, as given in his report, to permit of a distinct statement, in most cases, of the progress of the work under the Carnegie Institution grant.

Professor Pickering reports that in forming a corps of observers to study the photographs, time and money being limited, it was difficult to decide what subjects to select from this vast amount of material. A number of problems have accordingly been studied which serve to illustrate the various investigations which might be undertaken. Abridged results of a portion of these were promptly published in the Harvard Observatory Circulars nos. 69 and

70. The principal researches carried on are as follows: (1) Eclipses of Jupiter's satellites; (2) light curves of Algol variables; (3) position and brightness of stars in clusters; (4) observations have been made of the changes in light of nine variable stars of long period, during several years before they were discovered; (5) early observations of stars of the Algol type and other variables of short period; (6) transit photometer; (7) Nova Geminorum; (8) variations in brightness of Eros; (9) proper motion of stars; (10) missing asteroids, and (11) many images of interesting objects like new stars, variables and asteroids doubtless appear on the photographs. An examination has accordingly been made of several of the plates to determine whether it would be advisable to examine a large number of them systematically for the discovery of such objects.

Wm. M. Reed, Princeton Observatory, Princeton, N. J. *For pay of two assistants to observe variable stars.* $1,000.

Abstract of Report.—Owing to the difficulty of obtaining an observer, work was not begun till March 1. During the seven months from March 1 to October 1, the 23-inch telescope of the Halsted Observatory, exclusively for photometric work, was used on every clear night from early in the evening until daylight. In all 9,015 observations were made on about fifty different stars.

Three classes of stars were observed:

(*a*) Such variable stars as are too faint to be reached by any except the largest telescopes. In particular, selection was made of stars that have become too faint for the Harvard observers and those cooperating with them.

(*b*) Measurement of faint stars that are to be used as standards of magnitude. In this work they are connecting stars of the thirteenth magnitude with those of the fifteenth magnitude. The Lick and Yerkes observatories are connecting the fifteenth magnitude stars with the sixteenth magnitude, and the Harvard Observatory is connecting the eleventh magnitude with the thirteenth magnitude.

(*c*) A special study of the newly discovered Algol variable, 4.1903 *Draconis*, has been made, and a preliminary article giving the results of these observations has been sent to the *Astronomical Journal.*

Mary W. Whitney, Vassar College, Poughkeepsie, N. Y. *For measurement of astronomical photographs, etc.* $1,000.

Abstract of Report.—This work consists in the measurement and reduction of stellar photographs taken at the observatory at Helsingfors, Finland, by Professor Donnor. The measurement of the eight plates is finished and the reduction is well along. A preliminary catalogue of the mean places of 404 stars within two degrees of the pole is nearly completed. The work was pressed during the last quarter, as Professor Whitney then secured the services of an expert computer. The intercomparison of the plates and the determination of proper motion remain to be studied.

BIBLIOGRAPHY.

Robert Fletcher, Army Medical Museum, Washington, D. C. *For preparing and publishing the 'Index Medicus.'* $10,000.

The 'Index Medicus' was established in 1879, under the direction of Dr. John S. Billings and Dr. Robert Fletcher, and discontinued in 1899, after twenty-one volumes had appeared, for the lack of pecuniary support.

Abstract of Report.—The scope of this work is very broad with relation to the medical sciences. It contains, in classified form, month by month, reference to everything published throughout the world which relates to medicine or public hygiene. The latter comprises all that concerns the

public health in its municipal, national and international relations.

Nine numbers of the volume have been issued, and the volume will be complete with the January number, when the 'annual index' will be compiled. The index is a very elaborate piece of work, and will comprise 200 pages in double or triple columns. The work is of great value to all the medical profession, especially to professors in medical schools and colleges, officers of health and workers in scientific laboratories.

The subscribers to the 'Index Medicus' are chiefly residents of the United States, but the list includes subscribers in England, Ireland, Scotland, Canada, Australia, France, Germany, Spain, Portugal, Roumania, Sweden, Switzerland and Manila. There are now 455 subscribers.

HERBERT PUTNAM, Librarian of Congress, Washington, D. C. *For preparing and publishing a 'Handbook of Learned Societies.'* $5,000.

In order that the scientific investigators of this country, and especially those connected with the Carnegie Institution, might have an accurate knowledge of the agencies which now exist for the promotion of scientific inquiry in every part of the world, the advisory committee on bibliography recommended that a descriptive catalogue be prepared of all the learned societies of the world.

At the present time such information, and particularly regarding the publications of learned societies, is incomplete and unorganized, being scattered through a large and miscellaneous collection of volumes, many of which are inaccessible and not well known. A careful and comprehensive list would be of great value to all the librarians of the country who aim at the preservation of the transactions of learned bodies. It would also furnish a basis for exchanges. The funds for research work held by these various institutions have special significance with reference to the activities of the Carnegie Institution. The plan of the handbook included information as to these eleven points: (1) Name or names of the society or institution, indicating any change which may have occurred, with cross references; (2) objects of the society; (3) brief historical note; (4) endowments, research funds, prizes, etc; (5) officers of the society; (6) membership, numbers, conditions and manner of election, dues, etc.; (7) meetings—their character, frequency, time and place; (8) communications—regulations for presentation and publication of papers; (9) list of officers, with address of corresponding secretary; (10) complete and detailed bibliography of all regular or special publications since the foundation of the society, editions (how large?) to satisfy all the above mentioned requirements; (11) publications—conditions and methods of distribution; prices.

According to the plan of work approved, the handbook is to be in volumes; societies to be classified by subjects, with local arrangement, and each class to constitute a separate part. The following order of procedure has been adopted: (*a*) To prepare a list of societies from the exchange lists at the Smithsonian Institution and elsewhere in Washington, and a card catalogue to keep orderly record of communications; (*b*) to issue a suitable circular to these societies, requesting the desired information; (*c*) to prepare for publication the material received, filling out lacunæ by further correspondence and reference to various sources of information; (*d*) in the case of societies not replying to circular or letter, and in regard to which sufficient information can not be obtained from printed sources, to adopt such other methods as the progress of the work may suggest.

The first stage of this work was the preparing of a card catalogue of names of

learned societies and institutions. Every source of information known and available in the Congressional Library was searched to make this as nearly complete as possible, at the same time separating (1) dead societies and (2) societies not publishing any material of importance to investigators.

The second stage of the work was the sending of a circular letter, containing an outline of the information required, to academies and societies dealing with historical and social science in Europe and North America. Russia and other Slavic countries, and also Austria and Hungary, are being treated independently, advantage being taken of a visit to Russia by Mr. A. V. Babine, of the Library of Congress. Mr. Thompson and Mrs. Thompson made personal visits to England, Paris, Belgium, Holland and Berlin for the purpose of supplementing the information obtained by correspondence. It is anticipated that Mr. Thompson will also visit Italy and Switzerland.

The third stage of the work, the reduction of the replies received to standard form, was begun in August, and is now going on in the office at Washington. It is expected that this work will be brought to completion in 1904.

BOTANY.

W. A. Cannon, New York Botanical Garden, N. Y. *For investigation of plant hybrids.* $500.

Abstract of Report.—Under this grant Mr. Cannon worked at the New York Botanical Garden until September 1, 1903. He prepared a paper on the spermatogenesis of the hybrid peas and collected material for the study of the sporogenesis of two fern hybrids.

H. S. Conard, University of Pennsylvania, Philadelphia. *For study of types of water-lilies in European herbaria.* $300.

Abstract of Report.—The grant made to Mr. Conard was to enable him to examine the types of water-lilies in various European herbaria for the purpose of completing a memoir on water-lilies which the Carnegie Institution is about to publish. He was successful in obtaining the requisite data, and the memoir will soon go to press.

Desert Botanical Laboratory (F. V. Coville and D. T. MacDougal, Washington, D. C.). $8,000.

At the meeting of the trustees in November, 1902, a comprehensive plan for the encouragement of botanical researches was submitted by the advisory committee on botany (see 'Year Book,' No. 1, pages 3–12).

In carrying out this plan, Mr. F. V. Coville, botanist of the Department of Agriculture, Washington, and Mr. D. T. MacDougal, director of the laboratories of the New York Botanical Garden, were requested to go to the arid lands of the west and make such further recommendations as might seem to them best. They became persuaded that the best position for the laboratory, considering both natural and artificial advantages, is Tucson, Arizona, and they recommended its establishment there and the engagement of Dr. W. A. Cannon to be resident investigator.

A full report with respect to the organization of this laboratory and of the various circumstances which led up to it will be published in a monograph soon to be printed among the publications of the Carnegie Institution.

Abstract of Report.—Messrs. Coville and MacDougal were appointed a committee on the subject of a desert botanical laboratory.

After their visit to the principal points in the southwestern desert region, a laboratory location was selected near Tucson, Arizona.

The building site, water supply, road and electrical connection were presented by the Chamber of Commerce of Tucson, the cash

value of these concessions amounting to about $1,400, and the discussions that took place initiating what is still more valuable —the hearty interest and cooperation of the citizens in the purposes of the laboratory.

A laboratory building has been planned, contracted for and completed, the contract price being $3,843. The laboratory has been equipped with books, apparatus, furniture and supplies, at a cost of $1,813.50.

Dr. W. A. Cannon, recently connected with the New York Botanical Garden (Bronx Park), New York, was appointed resident investigator, and took charge of the laboratory September 1. He is now engaged in investigating the root systems of desert plants with reference to their special devices for the absorption and storage of water.

The privileges of the laboratory have been granted to Professor Charles B. Davenport, University of Chicago, for an inquiry into the morphological and physiological adjustment of desert animals to their habitat. Other applications are pending.

The committee has presented an illustrated report on the laboratory location, which is now in press as a publication of the institution.

E. W. OLIVE, Crawfordsville, Ind. *Researches on the cytological relations of the Amœbæ, Acrasieæ and Myxomycetes.* $1,000.

Abstract of Report.—Mr. Olive's work has been carried on in Professor Strasburger's laboratory in the Botanical Institute at Bonn, Germany. In order to do this work he resigned his position as instructor at Harvard University. His studies include cultures of the Acrasiæ and of the Labyrinthuleæ, which he had brought from America.

Mr. Olive's report shows definite progress in his research, and the prospect of the completion within two months of two papers incorporating a portion of his results.

JANET PERKINS, working at the Royal Botanical Gardens, Berlin, Germany. *For preliminary studies on the Philippine flora.* $1,900.

Abstract of Report.—Dr. Janet Perkins reports that she was engaged in the proposed investigation from February 20 to October 5, 1903. A catalogue of the Philippine flora was begun, based on various monographs and papers which have appeared in scientific periodicals. This work consumed much time, as literature regarding the Philippines is greatly scattered, and the synonymy needs a thorough clearing up.

Among other matters that were begun were: (*a*) A catalogue of the various native names, (*b*) a list of botanical literature pertaining to the Philippines, (*c*) the attempt to construct a type herbarium of Philippine plants, (*d*) the determination of certain Philippine plants received from the Department of Agriculture, and (*e*) the preparation of a sample copy of the manuscript and illustrations for the position of the family Marantaceæ.

CHEMISTRY.

W. D. BANCROFT, Cornell University, Ithaca, N. Y. *For a systematic chemical study of alloys, beginning with the bronzes and brasses.* $500.

Abstract of Report.—The experimental work under this grant has been done by Mr. E. S. Shepherd, under the direction of Professor Bancroft. They have analyzed the different solid bases and determined the copper-tin-lead diagram except for the alloys containing less than twenty per cent. of copper. They have determined the densities and electromotive forces of the

annealed bronze, and made a careful microscopic study of the same alloys. Work is now under way on the density and determination of bronzes cast in vacuo, the copper-tin-lead diagram, and the making of the necessary analyses. A study of the physical properties of bronzes will be carried on during the winter.

L. M. Dennis, Cornell University, Ithaca, N. Y. *For investigation of the rare earths.* $1,000.

Professor Dennis has been engaged for the past ten years in the study of the rare earths, and has accumulated a large amount of purified material. He proposed to carry on a study with special reference to improvements in the methods for determining the atomic masses of these substances, and for separating the elements of the yttrium group.

Abstract of Report.—The work under this grant was carried on by Dr. Benton Dales in the laboratory of Professor Dennis, of Cornell University. Dr. Dales has submitted a report on the ammonium carbonate and acetic acid method of fractionation. The source of the rare earths used in the work was xenotine, essentially a phosphate of the yttrium group of earths from Brazil. The work is unfinished, owing to Dr. Dales having resigned his position at Cornell University before completing it. Three fourths of the grant was used. A paper containing the results of the investigation, as far as obtained, was transmitted for publication.

H. C. Jones, Johns Hopkins University, Baltimore, Md. *For investigations in physical chemistry.* $1,000.

Abstract of Report.—Under the direction of Professor Jones, Dr. F. H. Gatman began work October 1, 1903, by investigating certain apparently abnormal phenomena manifested by concentrated solutions of electrolytes in water and other solvents. They expect to be able to report considerable progress by the end of the year.

H. N. Morse, Johns Hopkins University, Baltimore, Md. *For researches on osmotic pressure.* $1,500.

Abstract of Report.—Professor Morse reports that the immediate problem to be solved was the development of a practical method for measuring osmotic pressure. Although osmotic pressure has been recognized for twenty-five years as one of the great forces of nature, there have been no direct measurements to furnish an adequate experimental basis for the laws supposed to govern it. Professor Morse has been engaged for several years in attempting to overcome the difficulties which lie in the way of quantitative measurements of osmotic pressure. He states the problem under three heads, as follows: (1) The preparation of a suitable semipermeable membrane, (2) the overcoming of the mechanical difficulties in assembling the different parts essential to the complete osmotic cell, and (3) the production of an efficient porous wall on which to deposit the semipermeable membrane.

Professor Morse has succeeded in solving the problems designated by (1) and (2), and the work since October, 1902, has been prosecuted by him and Mr. J. C. W. Fraser, working in the laboratory of the Johns Hopkins University. They have found it necessary not only to work out theoretically, but also practically, the problem of the production of a suitable porous wall, necessitating the molding of the clay under great pressure in order to give the cell wall a higher and more uniform degree of compactness than is secured by the usual methods of the potter, and to remove thoroughly the air blisters and cavities which render most porous walls unfit for experimental work in osmotic pressure. Their

attention was, therefore, turned, in the second place, to the devising of apparatus for the forming of the clay vessels under pressure, with the result that they now possess two pieces of apparatus which work to entire satisfaction. They next proceeded to take up the problem of baking the clay vessels, and devised an electric kiln which was effective and well adapted to general use in the laboratory. They are now ready to begin the making, baking and burning of porous cells.

A. A. NOYES, Massachusetts Institute of Technology, Boston, Mass. *For certain chemical investigations.* $2,000.

Abstract of Report.—The work under the direction of Professor Noyes, on the electric conductivity of salts and aqueous solutions at high temperatures, has been in progress for several months, with the assistance of Dr. William D. Coolidge. Much of the time has been given to the construction of an effective platinum-lined conductivity cell or bomb, suitable for exact conductivity measurements with aqueous solutions up to 306° or higher, and in other preparatory work.

Now that the serious difficulties in the production of the conductivity apparatus, suitable for measurements at high temperatures and pressures, have been overcome, and the possibility of obtaining accurate results has been demonstrated by a series of determinations extending with a few salts up to 306°, it is highly desirable to extend the measurements to salts of other types and to acids and bases, and to the critical temperature of 360°. This work is very difficult and it will be necessary to continue it for a number of years before it will be completed.

Two other researches for which the aid granted was employed were begun in September, with the assistance of Dr. Herman C. Cooper and Mr. Yogoro Kato.

THEO. W. RICHARDS, Harvard University. *For investigation of values of atomic weights, etc.* $2,500.

Abstract of Report.—Professor Richards has submitted a memoir about to be published by the Carnegie Institution, containing the records of his experiments on a new method of determining compressibility. By means of this method the compressibilities of bromine, iodine, chloroform, bromoform, carbon tetrachloride, phosphorus, water and glass have been determined over a range of 700 atmospheres.

Besides the continuation of the preceding work, several other investigations are in progress, assisted by this grant. One of these concerns the effect of pressure on the electrochemical solution tension of metals; another concerns the heat capacity of solutions, and another concerns the atomic weight of sodium.

J. BISHOP TINGLE, Illinois College, Jacksonville, Ill. *For continuing investigations on the derivatives of camphor and allied bodies.* $500.

Abstract of Report.—The work under this grant was not begun till late in the summer. A number of bases have been tested as to their power to undergo condensation with camphoroxalic acid and its ethylic salt. Experiments have also been made to obtain further information as to the possible presence of hydroxyl groups in camphoroxalic acid, with encouraging results.

ENGINEERING.

W. F. DURAND, Cornell University, Ithaca, N. Y. *For experiments on ship resistance and propulsion.* $4,120.

Abstract of Report.—Professor Durand reports that certain equipment necessary for the conduct of the experiments was completed early in the spring. Experiments in connection with the work on propellers were begun, and all of the work of

observation required for the complete determination of the performance of thirty-five model propellers was finished. To complete the investigation immediately in view, fourteen propellers remain to be experimented with. He feels that the complete experimental determination for thirty-five propellers constitutes a most satisfactory summer's work. This is five sevenths of the entire field to be covered by this particular investigation. The work of making the detailed reductions and analyses of these observations will presumably occupy most of the winter. But very gratifying progress has been made in the preliminary measurements, speed having been determined from distance and time records in 444 cases and thrust-turning momentum determined by integration from autographic records in 655 cases.

Leonard Waldo, New York City. *For study of aluminum bronzes.* $4,500.

Abstract of Report.—Mr. Waldo reports that through the death of his associate, George S. Morison, and the break down in health of his chief assistant progress has been slow; he is unable to do more than report progress. He (*a*) prepared a bibliography on alloys of aluminum and copper and of other aluminum compounds; (*b*) has had in operation six kinds of specially built furnaces, and is building a seventh, to determine the best methods for making large castings and sound wire bars or billets of aluminum bronze; (*c*) his rolling mill experiments for producing tubes, sheet, wire and forged bars, from billets cast during the year, are practically complete and are satisfactory.

Notes taken during the process of rolling and cold drawing, relative to temperature, speeds and cost are awaiting collation and reduction. A complete report will be prepared during the coming year.

EXPLORATION.

Raphael Pumpelly, Newport, R. I. *For preliminary examination of the trans-Caspian region.* $6,500.

Abstract of Report.—The reconnaissance covered a region of 1,750 miles in length, with trips from 10 to 300 miles away from the railroad base. Throughout the great part of this area the remains of ancient occupation abound, in the form of large tumuli, village sites, fortresses and cities.

The structure of the tumuli examined and their contents indicate a very remote beginning and occupation during long periods. The builders had apparently archaic pottery, no metals, slight knowledge of stone implements and probably wooden weapons. The people were settled and had the domestic horse, cow, pig, sheep and goat. Many of these seats of early dwelling seem to have become in time eminences upon which arose fortresses, or to have become the citadels of towns growing up around them. Thus they probably contain the continuous record of the development of the civilizations of the region from a very remote antiquity down to historic times.

The reconnaissance work of Professor Davis, Mr. Huntington and R. W. Pumpelly has shown the former existence of several glacial epochs, and has made much progress in correlating these with the progress of prehistoric physical events in the building of the plains and the expansions of the former Aralo-Caspian seas. Their observations give reason to hope that further study will correlate these physical events with important phases of human development in connection with Asiatic and European history.

GEOPHYSICS.

Frank D. Adams, McGill University, Montreal, Can. *For investigating the flow of rocks.* $2,500.

Professor Adams has been engaged for some years past in an experimental investigation into the nature of the movements set up during the folding and deformation of the rocks of the earth's crust.

Abstract of Report.—Dr. Adams reports that McGill University has provided for his use in carrying on the investigation on the flow of rocks a large room in the basement of the new chemical building of the university. In this room he has installed the apparatus he formerly had and ordered a third and much more powerful hydraulic press, by which pressure up to 120 tons may be secured and maintained, if necessary, for weeks at a time. Ample provision has been made in the installation of the new hydraulic press, looking to the possibility of the extension of the plant in its adaptation to the most varied experimental uses.

On the completion of the installation Dr. Adams commenced the investigation of high differential pressures on dolomites from Maryland, Massachusetts and the province of Quebec. It was found that at ordinary temperatures these dolomites could be made to flow in the same manner as in the case of the pure Carrara marble. He is now carrying on experiments to ascertain the effect of heat upon the flow of dolomite. In order to compare the effects produced at high pressures with those produced by lower pressures, the higher representing the condition at lower depths in the earth's crust, experiments have been begun on the flow of marble with the 120-ton press.

Dr. Adams is also carrying on a series of investigations into the force required to drive water Portland oolite, which is the rock he has selected for further experiments on the deformation of limestones when heated, with water passing through them. He has also assembled material to commence the study of granite essexite and diabase, as typical igneous rocks under very high pressures at ordinary temperatures.

C. R. VAN HISE, University of Wisconsin, Madison, Wis. *For investigating the subject of geophysical research, etc.* \$2,500.

In the 'Year Book' for 1902, page 26, an extended report was presented on the subject of geophysics. As the trustees were not prepared to act upon the project, a further study of the problem was made, at the request of the executive committee, by Professor Van Hise, who investigated the subject of geophysical research in European institutions and made a report, which is printed in the 'Year Book.'

GEOLOGY.

T. C. CHAMBERLIN, University of Chicago, Chicago, Ill. *For study of the fundamental principles of geology.* \$6,000.

Abstract of Report.—Plans for the consideration of the different phases of the complex subjects of this investigation were arranged with numerous collaborators, and details of this collaboration and the results obtained are given in Professor Chamberlin's report printed in the 'Year Book.'

BAILEY WILLIS, U. S. Geological Survey, Washington, D. C. *For geological exploration in eastern China.* \$12,000.

This grant was for the purpose of carrying on a comparative study of the geology of eastern Asia and western North America, by observations in stratigraphy, structure and physiography in eastern China and Siberia, and by the collection of fossils, particularly with reference to the development of the Cambrian faunas.

He proposed to begin his inquiries in the mountain district in Shantung—the Taishan—a geological unit of about 4,000 square miles, where a study could be made of the geology from pre-Cambrian gneisses to the Coal Measures.

Mr. Eliot Blackwelder, an instructor in elementary geology and paleontology in the University of Chicago, accompanied Mr. Willis.

Abstract of Report.—Under date of September 30, 1903, from Tientsin, China, Mr. Willis reports that all preparations are completed, that authority has been received from the Chinese and German governments, and that with his associate, Mr. Blackwelder, he is about to leave for the province of Shantung. From Shantung it is proposed to go to Liautung. Mr. Willis expects to return to Pekin January 1, 1904, and as soon as may be thereafter to enter upon a trip that will probably continue until the end of June, 1904.

HISTORY.

Worthington C. Ford, Library of Congress, Washington, D. C. *For an examination of the historical archives of Washington.* $2,000.

For the purpose of studying the historical archives of Washington and ascertaining their extent and their characteristics, Mr. Ford prepared a scheme of inquiry which was arranged in two divisions. The first division included a general statement of the contents of each repository of archives, a statement of the place in which it is contained, and the history of the collection; also a statement of the funds available for the maintenance of the collection and of the conditions under which documents are accessible. The second division referred to the preservation of the collections and the arrangements for enlarging them.

Abstract of Report.—The purpose of this grant was to defray the expense of making a general survey of the archives of the government and the preparation of a report which would be helpful to historical investigators. Dr. Claude H. Van Tyne and Mr. Waldo G. Leland began the work in January, 1903, following general suggestions offered by Mr. Ford. They have examined the manuscript material in every branch of the government, and have prepared a statement as to the nature and extent of the administration records, as well as of the more important collections of historical material. This description is now nearly ready for printing. It will make a book of 250 or 300 pages of the size of the 'Year Book.' While it does not attempt to describe individual documents, but only classes and collections of documents, it is sure to be helpful to historical scholars seeking material.

PALEONTOLOGY.

E. C. Case, State Normal School, Milwaukee, Wis. *For continuation of work on the morphology of Permian reptiles.* $500.

Abstract of Report.—In connection with the preparation of a monograph on the Pelycosauria of the American Permian deposits, Professor Case spent most of the summer in the British Museum and several weeks in the museums of Paris and Berlin in the study of the reptiles of Permian age contained therein. The main line of work resolved itself into a careful comparison of the faunas of the deposits of America, Russia and South Africa. The most important result was the demonstration that American forms are practically completely different from those of Russia and South Africa, the sole connecting faunas being of the most primitive type, and none, so far as known, being common. This emphasizes the peculiarity of the presence of a typical American Pelycosaurian in the deposits of Bohemia. Professor Case also obtained many isolated facts of morphology that will be of material assistance to him in the study of the fauna.

O. P. HAY, American Museum of Natural History. *For monographing the fossil Chelonia of North America.* $2,200.

Abstract of Report.—Dr. Hay reports that he has prepared 200 pages of typewritten manuscript, and has had made, under his personal supervision, 210 drawings and 80 photographs of fossil turtles. He finds that there are about 180 species, and that there yet remains much to be done before the monograph will be ready for publication. During the summer he spent two months in the Bridger deposits of Wyoming, collecting fossils, and secured 135 specimens of turtles that will add greatly to our knowledge of Eocene forms.

G. R. WIELAND, Yale University, New Haven, Conn. *For continuation of his researches on living and fossil cycads.* $1,500.

Abstract of Report.—Dr. Wieland expects to have a memoir ready by the close of the calendar year, dealing with the fossil cycads from a biological standpoint. He has developed a new method for the study of fossil cycads by perfecting or inventing inverted drills, by means of which he has secured leaves, branches, fruits, flowers and terminal buds in the form of cylindrical cores cut from the cycad trunks. He has also adopted the novel plan of cementing together again, in their original position, the parts of such cores resulting from the cutting of a series of thin sections, and in this way securing a second series, also complete. By these methods he has cut a dozen fruits, in various stages of growth, from a silicified cycad trunk. He has also cut thin longitudinal and transverse sections of flowers surrounded by leaf bases. It is now possible to make, in the case of cycads, intensive studies of single trunks, such as have never before been made in the case of any fossil plants.

S. W. WILLISTON, University of Chicago, Chicago, Ill. *For preparing a monograph on the Plesiosaurian group.* $800.

Abstract of Report.—Professor Williston reports that he investigated the type material of Plesiosaurs at Colorado College, University of Kansas Museum, the American Museum of Natural History in New York, the Museum of the Academy of Natural Sciences, Philadelphia, and the National Museum, Washington. Important material has been sent him from these and other sources, upon which he is at present engaged. He hopes to complete his study during the year 1904.

PHYSICS.

HENRY CREW, Evanston, Ill. *For study of certain arc spectra.* $1,000.

Abstract of Report.—Professor Crew reports that after the building of certain apparatus, which required several months, he began the experimental part of his work. He found unexpected difficulties in working with magnesium and zinc, the two metals in which he hoped to find the order of appearance of the lines of the spark spectra.

His second problem was to complete the maps of the spectra of cadmium and aluminum. The map of the cadmium arc has been completed; that of aluminum nearly so.

The difficulty of obtaining an oscillograph has delayed the beginning of work on the third problem, the determination of the E.M.F. curves with the 'rotating metallic arc.'

A. A. MICHELSON, University of Chicago, Ill. *For aid in ruling diffraction gratings.* $1,500.

Abstract of Report.—Professor Michelson encountered many serious difficulties in the ruling engines for diffraction gratings, most of which he now believes are overcome. The work is now being pushed

vigorously, and he hopes before another year to make a favorable report on the results obtained.

Harold Pender, Johns Hopkins University, Baltimore, Md. *For experiments on the magnetic effect of electrical convection.* $750.

Abstract of Report.—The object of Dr. Pender's grant was to perform in Paris, in conjunction with Mons. B. Cremieu, experiments on the magnetic effect of electrical convection and to confer with M. Poincaré concerning the same. Dr. Pender met with great success in clearing up a controverted question as to the presence of a magnetic field about a bare metallic surface when charged and set in motion, which field is in all probability due to what is usually termed a convection current of electricity.

R. W. Wood, Johns Hopkins University, Baltimore, Md. *For research, chiefly on the theory of light.* $1,000.

Abstract of Report.—Professor Wood reports that one half of the grant has been expended for the salary of an assistant, and that the balance he plans to expend for apparatus. Through the aid given he was able to accomplish much more experimental work than he otherwise could have done. During the year he obtained results which were published in seven papers, all of which pertain to researches connected with the theory of light.

A considerable amount of work was also done on an investigation on the dispersion of sodium vapor; this has not yet been published.

PHYSIOLOGY.

W. O. Atwater, Wesleyan University, Middletown, Conn. *For experiments in nutrition.* $5,000.

Abstract of Report.—The purpose of this grant was to promote researches involving the direct determination of the amount of oxygen consumed by man for sustaining the bodily functions. The grant has been expended chiefly for the services of experts and assistants, for devising and constructing or purchasing apparatus, for developing methods for the determination of oxygen and for efficiency tests and experiments with men in the apparatus.

Several tests of the efficiency of the apparatus and method of manipulation were made. The feasibility of the use of the apparatus for the experiments with men has also been tested by three experiments with different subjects, with satisfactory results. Attention is now being devoted to alterations and improvements in the apparatus and to modifications of methods; efficiency tests and experiments with men are also in progress.

Arthur Gamgee, Montreux, Switzerland. *For preparing report on the physiology of nutrition.* $6,500.

Abstract of Report.—Dr. Gamgee began and has carried on a study of the extensive literature on this subject, which had to be mastered for the purpose of the inquiry on which he was engaged. He began by inspecting European laboratories and by visiting scientific men in Europe. He also visited Professor Atwater, at Middletown, Conn., and acquainted himself with the work now in progress there. He also visited other Americans. It is probable that his complete report will be transmitted in May, 1904.

PSYCHOLOGY.

G. Stanley Hall, Clark University, Worcester, Mass. *For certain investigations on the anthropology of childhood.* $2,000.

Abstract of Report.—The result of Dr. Hall's work in connection with this grant is best indicated by the titles of the papers he has published, giving the results obtained during the year. These are (1) Reaction to light and darkness; (2) children's ideas of fire, heat, frost and cold; (3)

curiosity and interest; (4) showing off and bashfulness as phases of self-consciousness, and (5) marriage and fecundity of college men and women.

E. W. SCRIPTURE, Yale University, New Haven, Conn. *For researches in experimental phonetics.* $1,600.

Report.—Professor Scripture's report is printed in the 'Year Book.'

ZOOLOGY.

H. E. CRAMPTON, Columbia University, New York. *For determining the laws of variation and inheritance of certain lepidoptera.* $250.

Abstract of Report.—In order to obtain data for the problems of variation, their relation to selection and for the study of correlation, Dr. Crampton investigated the following material: (*a*) 848 cocoons of *Philosamia cynthia,* (*b*) 1,410 cocoons of *Samia cecropia,* (*c*) 400 cocoons of *Callosamia angulifera,* etc., (*d*) 75 cocoons (preliminary) of *Attacus orizaba,* and (*e*) one family, *Hypercheiria io.*

The data secured furnished material for examination into variation and selection by comparing: (*a*) Metamorphosing and non-metamorphosing, (*b*) the perfect and imperfect survivors, and (*c*) the mating and non-mating moths.

Dr. Crampton thinks that certain general conclusions are justified from the facts already determined. Surviving individuals are less variable than those which succumb; mating individuals are less variable than those which fail to mate, and the index of correlation of the pupal characters is higher for the selected individuals in both cases. In a word, selection proceeds upon a basis of deviations from type and upon a correlative basis.

J. E. DUERDEN, Chapel Hill, N. C. *For investigation of recent and fossil corals.* $1,000.

Abstract of Report. With a view to obtaining suitable material for continuing his researches on fossil corals, Dr. Duerden has lately visited the principal museums and geological surveys in Great Britain, where Paleozoic corals are most abundant. These museums, and also the Smithsonian Institution, have placed at his disposal numerous specimens. Other material has been purchased. These collections will be studied during the present winter, with the hope of showing the relationship of fossil to recent corals.

Dr. Duerden has deposited with the Carnegie Institution, with a view to its publication, the manuscript and drawings of a memoir entitled 'The coral *Siderastræa radians* and its post-larval development.' This work is illustrated by fifteen plates and numerous text figures and gives an account of the morphology of a coral and its growth for a period of four months. It carries the development of the coral much farther than any previous work and contains many fundamental results in madreporarian morphology.

C. H. EIGENMANN, Indiana University, Bloomington, Ind. *For investigating the blind fishes of Cuba.* $1,000.

Abstract of Report.—Dr. Eigenmann did not begin his work under the Carnegie grant until October. He expects to spend from four to six months in Cuba, during the entire breeding season, and to make general collections in the caves and streams. He will also make an effort to secure the blind fishes from the island of Jamaica. He has made arrangements with the Cuban government to cooperate with him, as far as practicable, in giving him facilities for carrying forward his investigation.

L. O. HOWARD, Department of Agriculture, Washington, D. C. *For preparing manuscript and illustrations for a monograph on American mosquitoes.* $2,000.

Abstract of Report.—Dr. Howard began his work by making arrangements to secure observers at points in the United States, Central America and the West Indies sufficiently different in their faunistic characteristics to promise comparatively little duplication. He also published an announcement of the proposed monograph for the purpose of attracting volunteer observers and contributors; and, through correspondence, a great deal has been done in that direction, both in the West Indies and the United States. He also utilized the services of a number of the members of his force in the Department of Agriculture in making collections and observations.

He reports that the results as a whole have been surprising to him. A number of new species of mosquitoes have been discovered and one new genus, and much important specific information regarding the geographic distribution of the different species has been gained. This information has been of special interest and value regarding the yellow fever mosquito (*Stegomyia fasciata*) and the different species of the malaria-bearing mosquitoes of the genus *Anopheles*. A new species of this genus was found in the immediate vicinity of Washington. Great advance has been made in following out the life histories of the different species and genera; this has been done for nearly one hundred species.

All the collections and specimens have not yet been received by Dr. Howard, but every observer will send a series of specimens of adults, eggs, larvæ and pupæ, together with cast larval skins of all species observed. These have been and will be accompanied by full notes of habits, etc., together with drawings of structural peculiarities.

H. S. Jennings, University of Michigan, Ann Arbor, Mich. *For experiments on the behavior of lower animals.* $250.

Abstract of Report.—Dr. Jennings, who is a research assistant of the Carnegie Institution, is now at the Marine Biological Laboratory at Naples, carrying forward investigations on the reactions and behavior of very low organisms, such as amœba and other rhizopoda. He expects to have a general work in regard to the behavior of the lowest organisms ready for publication during the year. He has submitted to the institution for publication a paper entitled 'Reactions to Heat, Light and other Stimuli in the Ciliate Infusoria and in Rotifera, with Considerations on the Theories of Animal Behavior.'

C. E. McClung, Kansas University, Lawrence, Kans. *To making a comparative study of the spermatogenesis of insects and other classes of arthropods, and if possible to determine the specific functions of the different chromosomes.* $500.

Abstract of Report.—Professor McClung reports that owing to the fact that his own work and that of others show the main features of insect spermatogenesis, he determined to make use of the grant for the prosecution of other more difficult and expensive studies. He commenced by purchasing some literature to which he did not have access, and began the search for an object upon which he might prosecute his investigations. There appeared to be two ways to get at the problem—to study the germ cells of hybrids or to experiment upon fertilized eggs in the early cleavage stages. He decided to adopt the first mentioned plan for the beginning of the work. With this object in view, he spent the summer at the Woods Hole marine biological laboratory, but did not succeed in obtaining satisfactory forms of hybrids. He feels certain, however, that if the proper animals are secured the true function of the chromosomes may be settled as definitely as any other fact relating to cell structure.

E. B. Wilson, Columbia University, New York. *For investigations in experimental embryology, etc., in Naples.* $1,000.

Abstract of Report.—Dr. Wilson utilized this grant to defray the expenses of a visit to the Naples Zoological Station, extending from February to July, during which time he was actively engaged on studies in experimental embryology. His first purpose was to search for available material for the experimental analysis of the early developmental stages in mollusks and annelids, which possess high theoretical interest in their bearings on the general problems of differentiation. He reports a large measure of success in this direction. He found two excellent objects for his research, and made as exhaustive an analysis of them as the time would permit. He demonstrated conclusively the mosaic character of the development in the molluscan egg, and obtained striking evidence of the self differentiation and specification of embryonic cells. This result is interesting from its bearing on the problem of differentiation and also, perhaps, in even a greater degree, through the firm basis which it gives for the general method and point of view in studies of cellular embryology.

A second general division of his work included the experimental study of prelocalization in the unsegmented egg, which yielded results of no less interest than the cleavage stages. Of these the most important relate to the embryonic basis of correlation and to the relation between quantitative and qualitative prelocalization in the germ.

Dr. Wilson adds a general comment on the nature of this work to the effect that its principal significance lies in its connection with recent studies of the cellular basis of inheritance and development, taken in connection with experimental studies of heredity such as those that have grown out of the rediscovery of the Mendelian law. He is fully persuaded that there is now a very good prospect of making an essential advance toward an understanding of the actual mechanism of hereditary transmission, and expresses the hope that the studies in this direction may receive their due share of support.

H. V. Wilson, University of North Carolina, Chapel Hill. *For morphology and classification of deep sea sponges.* $1,000.

Abstract of Report.—In order to complete his investigation of the deep sea sponges of the Pacific Ocean, Professor Wilson visited the museums of London, Paris, Leiden and Berlin to make a direct examination of the types stored therein. He returned to America in August, and is at present engaged upon the text of his report.

Marine Biological Laboratory, Woods Hole, Mass.; J. Blakely Hoar, treasurer. *For maintenance of twenty tables.* $10,000.

Abstract of Report.—This appropriation was made for the purpose of aiding the laboratory by paying for the maintenance of twenty research tables. The persons assigned to the tables were selected by the Carnegie Institution.

The following investigators occupied the Carnegie tables during the season of 1903: (1) Professor M. A. Bigelow, Columbia University, N. Y.; (2) Dr. R. M. Strong, University of Chicago, Ill.; (3) Professor C. E. McClung, University of Kansas, Lawrence; (4) Professor George Lefevre, University of Missouri, Columbia; (5) Professor Wm. E. Kellicott, Barnard College, N. Y.; (6) Professor Arthur W. Greeley, Washington University, St. Louis; (7) Mr. C. J. Brues, Columbia University, N. Y.; (8) Mr. Fred. E. Pomeroy, Bates College, Lewiston, Me.; (9) Mr. J. W. Scott, Uni-

versity of Chicago, Ill.; (10) Dr. H. G. Spaulding, College of the City of New York; (11) Dr. Leo Loeb, McGill University, Montreal, Canada; (12) Dr. Henry Kraemer, Philadelphia, Pa.; (13) Mr. Grant Smith, Harvard University, Cambridge, Mass.; (14) Professor Joseph Guthrie, Iowa State College, Ames, Iowa; (15) Miss A. B. Townsend, Cornell University, Ithaca, N. Y.; (16) Mr. M. A. Chrysler, University of Chicago, Ill.; (17) Mr. Gustav Ruediger, Chicago, Ill.; (18) Miss Helen Dean King, Bryn Mawr University, Pa.; (19) Mr. James A. Nelson, University of Pennsylvania; (20) Professor Christian P. Lommen, University of South Dakota.

The director of the laboratory, Dr. C. O. Whitman, reports that the entire number of investigators at the laboratory during the season was 130, of whom 54 were students and 76 original investigators. He further states that every worker at the laboratory shares the general advantage secured by the Carnegie Institution grant; that most of the occupants of the Carnegie tables were investigators of established reputation, a few of them fellows from different universities engaged in their first original work; that it is not expected that the work undertaken will come to publication immediately, as in most cases it will necessarily extend over two or three years; that it is anticipated that the Carnegie support will not encourage hasty and fragmentary production, but will secure thorough work and permanent results.

Marine Biological Station, Naples, Italy. *For maintenance of two tables.* $1,000.

Abstract of Report.—One of the tables at this station was occupied for three months during the spring by Dr. E. B. Wilson, of Columbia University, and the other by Professor H. S. Jennnings, of the University of Michigan. The remainder of the year the tables were open to whomever the director of the laboratory might wish to assign to them. The arrangement with the laboratory was that the tables were intended for the use of persons engaged in original biological researches, and carried with them the right to be furnished with the ordinary material and supplies of the laboratory.

STUDENT RESEARCH WORK IN WASHINGTON, $10,000.

A special committee was appointed to consider the question of making provision for training in Washington students who desire to avail themselves of the various openings that may be offered to them. The executive committee, after full discussion, decided to place the report of the special committee on file, without action.

RESEARCH ASSISTANTS.

In pursuance of the policy approved by the trustees at their meeting in November, 1902, the sum of $25,000 was set aside by the executive committee for the purpose of assisting a certain number of young investigators who have shown exceptional ability and desire to pursue special lines of inquiry, under the oversight of qualified guides, more or less authoritative, according to the circumstances of each case.

Announcement of this plan was made by a printed circular, which was published in the winter of 1902–1903, and addressed to the heads of universities, colleges, laboratories, and other scientific institutions.

In response to this announcement 127 applications were received. These were distributed according to the subjects of investigation and referred to the confidential advisers, whose written opinions were laid before the executive committee with accompanying papers. The persons below named were then selected: J. H. Bair, Columbia University, New York, N. Y.; J. W. Baird, Cornell University, Ithaca, N. Y.; A. J.

Carlson, Stanford University, California; C. D. Child, Colgate University, Hamilton, N. Y.; Arthur B. Coble, Lykens, Pa.; W. W. Coblentz, Cornell University, Ithaca, N. Y.; Lee H. Cone, University of Michigan, Ann Arbor, Mich.; Elias Elvove, Lexington, Ky.; Shepherd I. Franz, Hanover, N. H.; L. E. Griffin, Missouri Valley College, Marshall, Mo.; Ellsworth Huntington, Milton, Mass.; Herbert S. Jennings, Ann Arbor, Mich.; George D. Louderback, Reno, Nev.; Albert P. Morse, Wellesley, Mass.; C. P. Neill, Catholic University, Washington, D. C.; Hideyo Noguchi, University of Pennsylvania, Philadelphia; James B. Overton, Jacksonville, Ill.; H. F. Perkins, University of Vermont, Burlington, Vt.; H. N. Russell, Kings College, Cambridge, England; George W. Scott, University of Pennsylvania, Philadelphia; R. M. Strong, Haverford, Pa.; H. G. Timberlake, University of Wisconsin, Madison; J. B. Whitehead, Jr., Johns Hopkins University, Baltimore; E. J. Wilczynski, Berkeley, Cal.; F. S. Wrinch, Princeton, N. J.

One of the persons thus selected, Mr. H. G. Timberlake, died in July, 1903, and one of them, Mr. C. D. Child, did not accept the appointment on account of a change in his plans. From all the others satisfactory reports of progress have been received, which again have been referred to specialists for their scrutiny and comment.

PUBLICATIONS AUTHORIZED.

The publication of eleven scientific papers has been authorized.

1. 'The Collected Mathematical Works of the Astronomer,' George William Hill.
2. 'Desert Botanical Laboratory of the Carnegie Institution,' by F. V. Coville and D. T. MacDougal.
3. 'New Method for Determining Compressibility,' by T. W. Richards and W. N. Stull.
4. 'Waterlilies—a Monograph of the Genus *Nymphæa*,' by H. S. Conard.
5. 'Fecundation in Plants,' by D. M. Mottier.
6. 'On the Behavior of Lower Organisms,' by H. S. Jennings.
7. 'The Coral *Siderastrea*,' by J. E. Duerden.
8. 'Catalogue of Double Stars,' by S. W. Burnham.
9. '*Chimera*—a Memoir on the Embryology of Primitive Fishes,' by Bashford Dean.
10. 'Host Index of Fungi,' by W. G. Farlow.
11. 'Results of Investigations of Poison of Serpents,' by Drs. Simon Flexner and Hideyo Noguchi.

APPLICATIONS RECEIVED.

All applications, from the beginning to October 31, 1903, are summarized in the following table:

LIST OF APPLICATIONS RECEIVED FROM BEGINNING TO NOVEMBER, 1903.

Subject.	Applications.			Amount Asked For.
	Not Stating Amount Desired.	Stating Amount Desired.	Total.	
Agriculture	3	1	4	$5,000
Anthropology	26	18	44	90,083
Archeology	11	5	16	17,700
Art	10	......	10	....
Astronomy	21	37	58	567,750
Bibliography	15	12	27	82,250
Biology	14	1	15	100,000
Botany	28	32	60	138,300
Chemistry	37	52	89	90,500
Economics	38	8	46	72,500
Education	20	1	21	500
Engineering	20	5	25	24,040
Exploration	2	3	5	110,000
Fellowship	39	2	41	1,700
Foreign	7	8	15	17,000
Geography	1	2	3	1,500
Geophysics	3	9	12	33,250
Geology	21	16	37	145,800
History	30	9	39	101,400
Inventions	21	2	23	2,100
Literature	10	......	10	....
Mathematics	11	9	20	13,525
Medicine	35	11	46	16,325
Meteorology	2	6	8	32,750
Miscellaneous	25	7	32	68,200
Paleontology	5	5	10	11,900
Philology	12	1	13	750
Psychology	22	15	37	77,600
Physics	32	26	58	37,350
Physiology	23	20	43	30,975
Publication	37	18	55	90,250
Religion	9	2	11	37,000
Zoology	46	63	109	182,400
Total	636	406	1,042	$2,200,398

GRANTS RECOMMENDED BY ADVISORY COMMITTEES.

In addition, the advisory committees have submitted a number of recommendations not included in the foregoing table. These are printed on pages xxxiv–xxxv of the confidential report to the trustees, issued November 11, 1902, and that for the southern and solar observatories in the present report:

Physics, per annum	$ 250,000
Geophysics, per annum	150,000
Psychology, per annum	45,000
Physiology, per annum	50,000
Southern Observatory, twelve years ($820,000), first year	80,000
Solar Observatory, twelve to fourteen years ($1,280,000), first year	150,000
History, per annum	17,500
Botany, per annum	24,000
Exploration, per annum	120,000
Geology, three years, per annum	25,000
Total	$ 911,500
Adding this to the total amount in above summary	2,200,398
Gives a total of	$3,111,898

The above total would have been still larger if all the grants had been made as requested. Frequently grants are requested for one year which, if made, would involve a number of subsequent grants before the completion of the work.

This is not intended as a close analysis of the amount of money desired. It merely shows the impossibility of making the present income of the Carnegie Institution provide for more than a small part of the grants requested.

Substantially all these applications have been carefully examined and considered. Many of the more important are explained in the first 'Year Book.'

Most of these applications have been considered unfavorably by the committee because they are not regarded as proper or useful purposes for expenditure from the income of the trust.

Some, however, have seemed to the committee only less important than the matters favorably reported upon, and these should, the committee thinks, be regarded as subjects of future consideration whenever available funds shall permit.

MEMBERSHIP IN THE AMERICAN ASSOCIATION.

The following persons have completed membership in the association since the publication of the last list of members, contained in Volume LII., Washington Proceedings, and corrected to June 15, 1903:

Albert, Harry Lee, professor of biology, State Normal School, Cape Girardeau, Missouri.

Allis, Edward Phelps, Jr., Palais Carnoles, Menton, France.

Anderson, William G., M.D., associate director, Yale Gymnasium, New Haven, Conn.

Ashton, Charles Hamilton, assistant in mathematics, University of Kansas, Lawrence, Kansas.

Avis, Edward S., Ph.D., president of the North Georgia Agricultural College, Dahlonega, Ga.

Bair, Joseph Hershey, Ph.D., Columbia University, New York, N. Y.

Baird, Robert Logan, Oberlin College, Oberlin, Ohio.

Balch, Alfred William, assistant surgeon, U.S.N., Navy Department, Washington, D. C.

Barck, Dr. Carl, 2715 Locust St., St. Louis, Mo.

Birge, Edward A., dean of the College of Letters and Science, University of Wisconsin, Madison, Wis.

Brown, George P., president of the Public School Publishing Co., Bloomington, Ill.

Blum, Sanford, M.D., 1243 Franklin St., San Francisco, Cal.

Cady, Hamilton Perkins, assistant professor of chemistry, University of Kansas, Lawrence, Kansas.

Cannon, W. A., Ph.D., Tucson, Arizona.

Clements, George E., M.D., 522 Capitol Ave., Springfield, Ill.

Comstock, Daniel F., 102 Huntington Ave., Boston, Mass.

Coombs, Zelotes Wood, professor of modern languages, Worcester Polytechnic Institute, Worcester, Mass.

Dozier, Melville, professor of mathematics and physical sciences, State Normal School, Los Angeles, Cal.

Easton, Christopher, deputy superintendent, Metropolitan Hospital, Blackwell's Island, New York, N. Y.

Ely, Robert Erskine, executive director, League for Political Education, 23 West 44th St., New York, N. Y.

Fox, Henry, 5603 Germantown Ave., Germantown, Philadelphia, Pa.

Frost, Arthur Barzilla, 33 Fay St., E. Cleveland, Ohio.

George, Russell D., professor of geology, University of Colorado, Boulder, Colo.

Gilchrist, John D. F., Ph.D., government biologist of Cape Colony, Department of Agriculture, Cape Town, South Africa.

Griggs, Robert F., professor of biology, Fargo College, Fargo, N. Dak.

Gruenberg, Benjamin C., teacher of biology, DeWitt Clinton High School, 60 West 13th St., New York, N. Y.

Harper, William R., LL.D., president of the University of Chicago, Chicago, Ill.

Harris, James Arthur, Shaw School of Botany, St. Louis, Mo.

Herzstein, M., M.D., 801 Sutter St., San Francisco, Cal.

Hoopes, H. E., Media, Pa.

Hotchkiss, Elmer Aro, president of Champaign County Board of School Examiners, Mechanicsburg, Ohio.

Hughes, Charles Hamilton, M.D., president of Barnes Medical College, 3857 Olive St., St. Louis, Mo.

Hulbert, C. E., secretary of department of anthropology, Louisiana Purchase Exposition, St. Louis, Mo.

Hurst, Julius H., M.D., 269 Canner St., New Haven, Conn.

Hutchinson, Susan A., librarian of the Museum of Brooklyn Institute of Arts and Sciences, Eastern Parkway, Brooklyn, N. Y.

Jones, Adam Leroy, Ph.D., tutor in philosophy, Columbia University, New York, N. Y.

Kasner, Edward, Ph.D., tutor in mathematics, Barnard College, Columbia University, New York, N. Y.

Kerr, William Jasper, D.Sc., president of the Agricultural College of Utah, Logan, Utah.

Kilgore, Benjamin Wesley, director of N. C. Agric. Exper. Station, Raleigh, N. C.

Landis, Edward Horace, instructor in physics and chemistry, Central High School, Philadelphia, Pa.

Lawrence, Florus F., chief of staff and surgeon, Lawrence Hospital for Women, Columbus, Ohio.

Levene, P. A., M.D., 1 Madison Avenue, New York, N. Y.

Livingston, Burton E., New York Botanical Garden, Bronx Park, New York, N. Y.

Lounsbury, Charles P., government entomologist, Cape Town, South Africa.

Low, Clarence F., Liverpool, London, Globe Building, New Orleans, La.

Lowe, Houston, Dayton, Ohio.

McCaustland, Elmer J., assistant professor of civil engineering, Cornell University, Ithaca, N. Y.

MacCracken, John H., president of Westminster College, Fulton, Mo.

McKay, John S., Packer Collegiate Institute, Brooklyn, N. Y.

Martin, Louis A., Jr., instructor in mathematics and mechanics, Stevens Institute, Hoboken, N. J.

Mayo, Caswell A., 1536 Fiftieth St., Brooklyn, N. Y.

Messenger, James F., professor of psychology, State Normal School, Winona, Minn.

Metcalf, Haven, professor of botany, Clemson College, S. C.

Miner, James B., instructor in psychology, University of Illinois, Urbana, Ill.

Mitchell, Guy E., secretary of National Irrigation Association, Washington, D. C.

Mojonnier, Timothy, care of Helvetia Milk Condensing Co., Greenville, Ill.

Moulton, W. H., assistant manager, Osborn Mfg. Co., Cleveland, Ohio.

Nutting, Perley G., National Bureau of Standards, Washington, D. C.

Pegram, George B., tutor in physics, Columbia University, New York, N. Y.

Porter, Fred. B., 4911 Champlain Ave., Chicago, Ill.

Ramsey, Miss Mary C., Shoshone Agency, Wyoming.

Rankin, J. M., Atlantic Building, Washington, D. C.

Reagan, Albert B., 327 S. Lincoln St., Bloomington, Ill.

Richardson, Leon B., instructor in chemistry, Dartmouth College, Hanover, N. H.

Riley, Mrs. Matilda E., art director, St. Louis Public Schools, Board of Education Building, St. Louis, Mo.

Rogers, Howard J., chief of department of education and director of international congresses, Universal Exposition, St. Louis, Mo.

Schober, Wm. Bush, Lehigh University, South Bethlehem, Pa.

Shurtleff, Eugene, M.D., 73 Hancock St., Dorchester, Mass.

Sinclair, Cephas Hempstone, Coast and Geodetic Survey, Washington, D. C.

Smith, Alton Lincoln, assistant professor of drawing and machine design, Worcester Polytechnic Institute, Worcester, Mass.

Spaulding, Perley, Missouri Botanical Garden, St. Louis, Mo.

Stewart, George Walter, professor of physics, University of North Dakota, Grand Forks, N. Dak.

Swift, Henry D., West Falmouth, Mass.

Thompson, Benj., chief engineer, T. & B. V. Ry. Co., Hillsboro, Texas.

Tiernan, Austin K., C.E., P. O. Box 441, Salt Lake City, Utah.

Torrey, Harry Beal, Ph.D., instructor in zoology, University of California, Berkeley, Cal.

Tower, Ralph Winfred, curator of physiology, Am. Mus. Nat. Hist., New York, N. Y.

Valentine, Morris Crawford, instructor in biology, High School, 259 West 131st St., New York, N. Y.

Veath, Arthur Clifford, U. S. Geological Survey, Washington, D. C.

Vogt, Frederick A., principal of Central High School, Buffalo, N. Y.

Wadsworth, Oliver F., 526 Beacon St., Boston, Mass.

West, Max, Ph.D., Treasury Department, San Juan, Porto Rico.

Wetherill, Henry Emerson, M.D., 3734 Walnut St., Philadelphia, Pa.

Whelpley, Dr. H. M., 222 South Broadway, St. Louis, Mo.

Woodruff, Lorande Loss, assistant in biology, Williams College, Williamstown, Mass.

Wrinch, Frank Sidney, Ph.D., instructor in experimental psychology, University of California, Berkeley, Cal.

Wylie, Robert Bradford, University of Chicago, Chicago, Ill.

SCIENTIFIC BOOKS.

General Zoology. Practical, Systematic and Comparative. By CHARLES WRIGHT DODGE. New York, American Book Company. Pp. 512; 379 figs.

As stated on the title-page, this work is a revision and rearrangement of Orton's 'Comparative Zoology.' It is evidently designed for elementary instruction in high schools, academies and colleges. About one third of the volume is devoted to a brief systematic review of the animal kingdom, the remainder to 'comparative zoology,' that is, a mixture of animal physiology, comparative anatomy, embryology, ethnology, distribution, etiology, etc. In the main, the work has been carefully written, though certain statements should be revised or corrected in a possible new edition. The insect figured as a cricket (*Gryllus*) on page 109 is a locustid, and the dragon-fly on page 111 is not a *Libellula.* The bird figured on page 172 is the resplendent trogon (*Pharomacrus mocinno*) and not *Trogon elegans,* which is a very different creature. Although the classification adopted is that of Parker and Haswell, the author includes the apocryphal group Mesozoa, at least in the 'ancestral tree' on page 201, though nothing is said about it in the text. *Amphioxus* is still regarded as a vertebrate, though this term is properly applicable only to the Craniota. In the chapter on the distribution of animals there are a few sweeping and inaccurate statements. On page 441 the author says: 'Each of the three great provinces, Earth, Air and Water, as also every continent, contains representatives of all the classes; but the various classes are unequally represented.' This sets one to wondering whether the American fauna may not comprise such things as flying tunicates and aërial holothurians, and whether terrestrial cyclostomes may not be discovered in the remoter regions of the 'dark continent.' In the chapter on the origin of animal species the definition of 'organic selec-

tion' is, to say the least, misleading. The word 'consciousness,' on the last page, is out of place in a text-book on zoology, especially when it is still a serious question whether this word should not be rigorously avoided even in works on comparative psychology. The binding, paper and typography are all that can be desired in a small work like that of Professor Dodge. The figures are clear, attractive and abundant. Perhaps there are proportionally too many figures of European and too few of American species, especially among the insects, for a book that will probably be more used in this country than abroad.

WILLIAM MORTON WHEELER.

SCIENTIFIC JOURNALS AND ARTICLES.

The Popular Science Monthly for December contains a careful discussion of 'Recent Theories in Regard to the Determination of Sex,' by T. H. Morgan, a history of 'The Academy of Science of St. Louis,' by William Trelease, and a description of 'The Tetrahedral Kites of Dr. Alexander Graham Bell,' by Gilbert H. Grosvenor. Dr. J. A. Fleming contributes the seventh and final paper on 'Hertzian Wave Wireless Telegraphy,' in which are presented some of the problems waiting for solution before it can be entirely successful. 'The Salmon and Salmon Streams of Alaska' are described by David Starr Jordan, the article containing an account of the food value of each species. 'The Storm Center in the Balkans,' by Allan McLaughlin, shows how the very mixed population of this region makes it a continual source of political trouble, while in 'The Growth of Rural Population' Frank T. Carlton shows the changes that have recently taken place in that direction. The concluding article, by the late R. H. Thurston, is on 'Rear-Admiral G. W. Melville, U.S.N., and Applied Science in Construction of the New Fleet.'

Bird-Lore for November–December contains 'An Island Eden,' by Frank M. Chapman, being an account of Gardiner's Island, N. Y.; 'The Turkey Vulture and Its Young,' by Thomas H. Jackson; the first of a series of articles on 'The Migration of Warblers,' by W. W. Cooke, and the seventh series of portraits of *Bird-Lore's* Advisory Councilors. There are the usual notes and book reviews and reports of the Audubon Societies. This last includes 'Educational Leaflets,' No. 6, on the passenger or wild pigeon. It is announced that the papers on warblers will be illustrated by colored plates, and the present number contains two. Eventually the series will appear in book form.

The Journal of Comparative Neurology has somewhat enlarged its scope, and will hereafter be called *The Journal of Comparative Neurology and Psychology.* Professor C. Judson Herrick, of Denison University, will continue to be the managing editor, and Dr. O. S. Strong, of Columbia University, will continue to be one of the associate editors, while Dr. Robert M. Yerkes, of Harvard University, will become associate editor with special charge of the departments dealing with the functions of the nervous system and comparative psychology. A large board of cooperating editors has also been secured. The subscription price will hereafter be $4, and the journal will hereafter appear bi-monthly, each volume containing about 500 pages.

PROFESSOR GUILIO FANO, of Florence, has decided to found a new periodical, to be entitled *Archivio di Fisiologia.* He will be assisted in the editorship by Professor Filippo Bottazzi, of Genoa. The *Archivio di Fisiologia* will especially concern itself with experimental work, but synthetic reviews and philosophical disquisitions will not be excluded. Papers will be published, according to the wish of the author, in one of the four official languages of the International Physiological Congress—English, Italian, German or French. The *Archivio di Fisiologia* will appear every two months, forming a yearly volume of about 500 pages.

The Museums Journal of Great Britain for November has papers on 'Copyright of Works of Art in the Museums of Great Britain,' by E. Ernest Lowe, which shows a very curious state of affairs; 'Early Monuments and Archaic Art of the Northeast of Scotland,' by W. M. Ramsay, and on 'Good Form in Nat-

ural History Museums,' by F. Jeffrey Bell. There are an interesting report of the meeting of the library association and many notes from various museums.

SOCIETIES AND ACADEMIES.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES.

The American Association for the Advancement of Science, the American Society of Naturalists and the following affiliated societies will meet at St. Louis, Mo., during the week beginning December 28.

The American Association for the Advancement of Science. The week beginning on December 28, 1903. President, The Hon. Carroll D. Wright; Permanent Secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; General Secretary, Dr. Chas. W. Stiles, U. S. Department of Agriculture, Washington, D. C.; Secretary of the Council, President Chas. S. Howe, Case School of Applied Science, Cleveland, Ohio. *Local Executive Committee,* President, Professor William Trelease; Secretary, Alexander S. Langsdorf.

Section A—Mathematics and Astronomy. Vice-president, O. H. Tittmann; Secretary, Professor L. G. Weld, University of Iowa, Iowa City, Ia.

Section B—Physics. Vice-president, Professor Edwin H. Hall; Secretary, Professor D. C. Miller, Case School of Applied Science, Cleveland, Ohio.

Section C—Chemistry. Vice-president, Professor W. D. Bancroft; Secretary, Professor A. H. Gill, Massachusetts Institute of Technology, Boston, Mass.

Section D—Mechanical Science and Engineering. Vice-president, Professor C. M. Woodward; Secretary, Professor Wm. T. Magruder, Ohio State University.

Section E—Geology and Geography. Vice-president, Professor I. C. Russell; Secretary, Dr. G. B. Shattuck, The Johns Hopkins University, Baltimore, Md.

Section F—Zoology. Vice-president, Professor E. L. Mark; Secretary, Professor C. Judson Herrick, Denison University, Granville, Ohio.

Section G—Botany. Vice-president, Professor T. H. MacBride; Secretary, Professor F. E. Lloyd, Teachers College, Columbia University, New York City.

Section H—Anthropology. Vice-president, Professor M. H. Saville; Secretary, Dr. R. B. Dixon, Harvard University, Cambridge, Mass.

Section I—Social and Economic Science. Vice-president, Judge S. E. Baldwin; Secretary, J. E. Crowell, U. S. Department of Agriculture, Washington, D. C.

Section K—Physiology and Experimental Medicine. President, Professor H. P. Bowditch; Secretary, Professor F. S. Lee, Columbia University, New York. There will be no meeting of Section K at the St. Louis meeting.

The American Society of Naturalists. December 29 and 30. President, Professor William Trelease; Secretary, Dr. Ross G. Harrison, The Johns Hopkins University, Baltimore, Md. *The Central Branch* of the society meets at the same time and place. President, Professor John M. Coulter; Secretary, Professor W. J. Moenkhaus, Indiana University, Bloomington, Ind.

The Astronomical and Astrophysical Society of America. December 29, 30. President, Professor Simon Newcomb; Secretary, Professor Geo. C. Comstock, Washburn Observatory, Madison, Wis.

American Physical Society. During convocation week. President, Arthur G. Webster; Secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society. December 28, 29. President, Professor John H. Long; Secretary, Professor W. A. Noyes, The Johns Hopkins University, Baltimore, Md.

The Geological Society of America. December 30, 31, 1903, January 1, 1904. President, Dr. S. F. Emmons; Secretary, Professor H. L. Fairchild, University of Rochester, Rochester, N. Y. *Cordilleran Section.* San Francisco. January 1, 2, 1904.

The American Mathematical Society—Chicago Section. Secretary, Professor Thomas F. Holgate, Northwestern University, Evanston, Ill. *San Francisco Section.* Berkeley, Cal. December 19. Secretary, Professor G. A. Miller, Stanford University, Cal.

Botanical Society of America. December 30, 31. President, B. T. Galloway; Secretary D. T. MacDougall, New York Botanical Garden, Bronx Park, N. Y.

The Central Botanists' Association. President, Conway MacMillan; Secretary, C. F. Millspaugh, Field Columbian Museum, Chicago, Ill.

The Botanical Club of the Association. Probably, at convenient times.

The Society for Horticultural Science. December 28, 29. President, Professor L. H. Bailey; Secretary, S. A. Beach, Geneva, N. Y.

The Fern Chapter. Time to be announced. President, B. D. Gilbert; Secretary, H. D. House, Botanical Garden, Bronx Park, New York, N. Y.

The Society for the Promotion of Agricultural

Science. December 28, 29 30, 31, 1903, January 1, 1904. President, Dr. William Frear; Secretary, Professor F. M. Webster, University of Illinois, Urbana, Ill.

American Society of Zoologists, Central Branch. December 29, 30, 31. President, Professor Jacob E. Reighard; Secretary, Professor Frank Smith, University of Illinois, Urbana, Ill.

The Association of Economic Entomologists. December 29, 30. President, Professor Mark V. Slingerland; Secretary, Professor A. F. Burgess, Ohio State University, Columbus, Ohio.

The Entomological Club of the Association. At convenient times. President, E. A. Schwarz; Secretary, C. L. Marlatt, Department of Agriculture, Washington, D. C.

The American Microscopical Society. December 28, probably. President, T. J. Burrill; Secretary, H. B. Ward, Lincoln, Nebraska.

Association of Plant and Animal Breeders. First general meeting. December 29, 30. Chairman of Committee, W. M. Hayes, University Farm, St. Anthony Park, Minn.

The American Anthropological Association. December 28, 1903, January 1, 2, 1904. President, Dr. W J McGee; Secretary, George H. Pepper, American Museum of Natural History, Central Park, New York City.

The American Psychological Association. December 29, 30. President, Dr. W. L. Bryan; Secretary, Professor Livingston Farrand, Columbia University, New York City.

The Sigma Xi Honorary Scientific Society. During convocation week. President S. W. Williston; Secretary, Professor E. S. Crawley, University of Pennsylvania, Philadelphia, Pa.

The National Educational Association, Department Presidents. About January 1, 1903. President, John W. Cook; Secretary, Irwin Shepard, Winona, Minn.

There will meet at Philadelphia:

The American Society of Zoologists, Eastern Branch. December 29, 30, 31. President, Dr. G. H. Parker; Secretary, Dr. G. A. Drew, University of Maine, Orono, Me.

The Association of American Anatomists. December 29, 30, 31. President, Professor G. S. Huntington; Secretary, Professor G. Carl Huber, University of Michigan, Ann Arbor, Mich.

The Society for Plant Morphology and Physiology. December 29, 30, 31. President, Professor Roland Thaxter; Secretary; Professor W. F. Ganong, Smith College, Northampton, Mass.

The Society of American Bacteriologists. December 29, 30. President, Professor Theobald Smith; Secretary, Professor E. O. Jordan, University of Chicago, Chicago, Ill.

The American Physiological Society. December 29, 30. President, Professor R. H. Chittenden; Secretary, Professor F. S. Lee, Columbia University, New York City.

There will meet at Princeton:

The American Philosophical Association. December 29 and 30. President, Professor Josiah Royce; Secretary, Professor H. N. Gardiner, Smith College, Northampton, Mass.

There will meet in New York:

The American Mathematical Society. Columbia University. December 28 and 29. President, Professor Thomas S. Fiske; Secretary, Professor F. N. Cole, Columbia University, New York City.

THE SOCIETY OF THE VERTEBRATE PALEONTOLOGISTS OF AMERICA.

AT a meeting held at Washington, D. C., December 31, 1902, which was attended by the persons whose names are printed in italics in the list given below, it was decided to organize a society of the vertebrate paleontologists of America. Of this society Professor S. W. Williston, of the University of Chicago, was chosen president and O. P. Hay, of the American Museum of Natural History, secretary. It was further decided that the meetings of this society should be held at the same time and place as those of the American Society of Zoologists. The following active workers in vertebrate paleontology were proposed as original members: *G. I. Adams,* E. H. Barbour, B. A. Bensley, B. Brown, E. C. Case, *Bashford Dean,* E. Douglass, C. R. Eastman, G. F. Eaton, J. Eyerman, M. S. Farr, S. Garman, J. W. Gidley, *Theodore Gill,* C. W. Gilmore, W. Granger, *J. B. Hatcher, O. P. Hay,* L. M. Lambe, J. Lindahl, F. B. Loomis, *F. A. Lucas,* W. D. Matthew, *J. C. Merriam, H. F. Osborn,* W. Patten, O. A. Peterson, E. S. Riggs, *W. B. Scott,* A. Stewart, J. F. Whiteaves, G. R. Wieland, *S. W. Williston,* J. L. Wortman.

Notice is hereby given that a second meeting of the society will be held, beginning December 29, 1903, in Philadelphia, at the University of Pennsylvania, at which meeting the organization of the society will be completed and papers will be read by several

members. Titles of papers have already been received from Messrs. Adams, Case, Eastman, Hay, McGregor, Loomis, Matthew, Merriam, Osborn, Patten, Scott and Williston. It is earnestly desired that all who are interested in the progress of the science may be present. Communications regarding the meeting may be addressed to the secretary.

S. W. Williston, *President.*
O. P. Hay, *Secretary.*

AMERICAN CHEMICAL SOCIETY. NORTHEASTERN SECTION.

The forty-seventh meeting of the section was held in the Lowell Lecture Hall, Massachusetts Institute of Technology, Friday, November 27, at 8 P.M.; President A. H. Gill in the chair. Seventy members were present.

The following officers for 1903–4 were elected:

President—W. H. Walker.
Vice-President—Henry Howard.
Secretary—A. M. Comey.
Treasurer—W. E. Piper.
Executive Committee—Henry Fay, H. A. Torrey, J. R. Marble, A. E. Leach and W. K. Robbins.
Councillors—John Alden, C. R. Sanger, H. P. Talbot.

The treasurer's and auditor's reports were presented.

President A. H. Gill reviewed the history of the section during the past year, and gave an address on 'Some Limitations of Technical Analysis,' showing some of the difficulties in the detection and separation of substances which have not yet been overcome.

Dr. Peter S. Burns followed with a paper entitled 'Some Experiments on Colloids,' showing by numerous experiments the various methods of preparing colloidal solutions, and their behavior under different conditions and with different reagents. The lecturer also described the various theories that had been proposed to account for the phenomena observed, and propounded a new theory as a tentative explanation of the same.

Arthur M. Comey,
Secretary.

SPECIAL MEETING OF THE WASHINGTON CHEMICAL SOCIETY.

A special meeting of the Washington Chemical Society was held in the chemical lecture room of the Columbian University at 8 P.M., November 23, 1903, for the purpose of taking appropriate action upon the death of Dr. H. Carrington Bolton.

The meeting was called to order by the president, who made a few remarks concerning the Christian spirit, gentlemanly conduct and unique work of the late Dr. Bolton. Dr. Cameron was followed by Professor Monroe, who read from the 'Bolton Genealogy,' which contained a short history of the life of Dr. Bolton, and was compiled by Dr. Bolton and his cousin. The account of Dr. Bolton's life showed him to have received exceptional educational advantages, having studied with such men as Bunsen, Wöhler, Von Hoffman and others. He traveled extensively. He taught at the School of Mines of Columbia College and held the chair of chemistry at Trinity College of Hartford, Conn., for ten years. He strove to impart knowledge in an attractive way. He is the author of more than one hundred and fifty scientific and literary contributions.

Dr. Marcus Benjamin then responded with a few recollections of his extended acquaintance with Dr. Bolton, and called especial attention to the enthusiasm with which Dr. Bolton undertook any work in which he became interested.

Dr. Clarke recalled a number of instances in the course of his friendship with Dr. Bolton. He emphasized particularly the value of Dr. Bolton's work upon the bibliography of scientific literature.

Dr. Wiley then spoke of his associations with Dr. Bolton, especially with reference to his knowledge of him as a man. He mentioned particularly his personality, his geniality and verity of friendship, sincerity and simplicity of mind and character.

Remarks were also made by Professor Long, president of the American Chemical Society, and also by Dr. Warder.

Letters of regret and personal interest in the motive of the meeting were received from

Dr. David W. Day, Mr. William Glenn, of Baltimore, and others.

In response to the formal motion made and carried, the president appointed a committee consisting of Professor Munroe, Dr. Clarke and Dr. Wiley to draft resolutions expressing the loss felt by the Washington Chemical Society in the death of Dr. Bolton.

A. SEIDELL, *Secretary*.

SHORTER ARTICLES.

SOME OSTEOLOGICAL TERMS.

IN the usual osteological nomenclature, there are certain terms, among others, which have been and yet are so loosely and indefinitely used that one is often in doubt as to their meaning. I refer more especially to 'hæmapophysis,' 'hæmal spine' and 'hypapophysis.' The first two of these were proposed by Owen in the *Geological Transactions*, Vol. V., p. 118 (1838). 'Hæmapophyses' was there defined and used as a synonym of 'chevron-bones'—"These are the chevron-bones of Mr. Conybeare, the paravertebral elements of Geoffroy St. Hilaire." In later years, especially in his 'Archetype and Homologies of the Vertebrate Skeleton,' Owen extended the meaning of the word to include the ischium, pubis, costal cartilages, etc., and he correctly suggested it for the intercentrum of the atlas in 1851. Cope in his posthumous work upon the lizards and snakes of North America uses hæmapophysis as a synonym of rib. As applied to the chevron-bones, the word is unnecessary, and, as extended to the other structures in Owen's transcendental theory, the term is inapplicable and mischievous. As is well known, the 'hæmapophyses' of fishes are formed chiefly by the deflection of the parapophyses, while the chevrons of reptiles are supposed to be of intercentral origin alone. Unfortunately, the phrase 'hæmal arch' has also had a very indefinite application, but its use is preferable to that of 'hæmapophyses.' In any event, I quite agree with Boulenger that the latter word should be banished utterly from anatomical nomenclature. The word chevron has become well fixed, and has, moreover, the advantage of being morphologically meaningless.

'Hæmal spine' was first proposed by Owen to indicate the spine of the united chevron. In this application among fishes it has a definite morphological meaning, though not often now so used. The term helped Owen to round out his symmetrical archetype of the vertebra, but, when he later applied it to so incongruous an assemblage of morphological elements as the sternum, episternum and hyoid, as well as the intercentra of the Squamata, it loses every particle of meaning it may have once had and should be discarded. Boulenger, however (*Proc. Zool. Soc. Lond.*, 1891), has proposed to use the phrase in a totally different sense from any suggested by Owen for the infracentral keel or spine of such vertebræ as those of the turtles, rabbits, etc.

Concerning 'hypapophyses' there is ground for differences of usage, yet I think it may be shown that the word should be restricted to those processes only which Boulenger would call hæmal spines. The term was not proposed by Owen until some time after he had formulated his archetypal theory, appearing, I think, for the first time in his 'Skeleton and the Teeth,' published in 1853 or 1854, where it was defined. It seems clear from this definition, as also from his discussion of the vertebra in his 'Archetype and Homologies,' that he intended the word primarily for infracentral exogenous processes. He calls the hypapophysis exogenous, but says it may sometimes be autogenous, like 'the diapophysis and the parapophysis.' As we now restrict the latter two terms solely to exogenous processes, the former should be also. Boulenger, however, prefers to apply the term to the autogenous elements alone, that is to the intercentra and chevrons, and so uses the word as a synonym of 'intercentrum.' Baur, apparently following Boulenger, in 1894 (*Proc. Nat. Mus.*) invented the term 'catapophysis' for what was evidently originally meant by hypapophysis, and what is called hæmal spine by Boulenger, and accepted hypapophysis in place of intercentrum.

Cope was the first to use the term intercentrum in the sense now employed for the hypaxial element in the amphibia and reptiles. The element in question, however,

had previously been called Zwischenwirbelbein by Von Meyer in *Sphenosaurus*, and, long before, Egerton, in 1836, had proposed the phrase 'subvertebral wedge-bone' for the same element in the ichthyosaurs. It may be of interest to observe that Marsh, as early as 1878 (*Amer. Journ. Sci.*, May), correctly recognized his 'intercentral bones' in the so-called hypapophyses of the Mosasaurs, though Boulenger, as late as 1891, denied their identity. Hypapophysis is yet frequently used for the intercentrum of the atlas, following Owen, and 'hypocentrum,' 'basiventral bone,' etc., are frequent and superfluous synonyms of intercentrum.

There is yet another anatomical term which bids fair to become confused in its application —splenial. Owen proposed the term ('Archetype and Homologies,' p. 15) in place of the Cuverian 'opercular,' a term inadmissible because of its double use in the fishes, for the splint-like element on the inner side of the mandible, and figured as typical of the mandible in the crocodile and ostrich. Baur, correctly, I believe, recognizing that the so-called splenial of the turtle is not morphologically identical with the splenial in the crocodile and lizard, but rather a dermal element separated from the articular, gave to it (improperly, I think) the name of angular, while the real angular he called the splenial, and for the real splenial he proposed the new name 'presplenial.' Lambe, recently, in his description of the mandibular elements in *Dryptosaurus*, retains the names previously used in the turtles, but calls the most anterior element, sometimes also present in the turtles, the presplenial. But, this is inadmissible. There can be little if any doubt but that the presplenial of *Dryptosaurus* and the testudinates is morphologically identical with the real splenial of the crocodiles and the lizards, and it must receive the same name. If we call it the presplenial, then Baur's arbitrary change of the angular must also be accepted, otherwise the crocodile, to whose mandible the name splenial was originally applied, is juggled out of a splenial entirely!

S. W. Williston.

University of Chicago.

THE ORIGIN OF FEMALE AND WORKER ANTS FROM THE EGGS OF PARTHENOGENETIC WORKERS.

Dzierzon's celebrated theory, according to which the unfertilized eggs of the honey-bee give rise to males, or drones, whereas fertilized eggs develop into females (queens or workers), has not only become one of the established tenets of apiculturists, but has also been expanded by theorists to include other social insects, such as the ants and social wasps. Nor is this expansion merely the result of a tempting analogy. Forel* and Lubbock† long ago showed that the eggs of parthenogenetic worker ants may develop into males, and more recently similar observations have been made by Miss Fielde.‡ These facts certainly confirm the Dzierzon theory and appear to justify its extension to the ants.

The further question, however, as to whether the unfertilized eggs of bees and ants may not, under certain conditions, give rise to workers, is still unanswered.§ In other words, the observation of a number of cases in which males developed from unfertilized eggs, is not in itself sufficient to preclude the possibility of the development of females or workers from such eggs under other circumstances. We know that this possibility is realized in the autumn broods of plant-lice, water-fleas, etc. That it may also be realized in ants is shown by the following observations made independently by three different observers and here quoted as a basis of suggestion for future experimental work. It is, perhaps, timely to stress these observations, for theorizing on sex determination is much in vogue and is being indulged in by some who seem to derive their facts from any but the original sources. That some of these observations have been 'snowed under'—*todtgeschwiegen*, as the Germans say—is not a matter of surprise when we consider the blinding

* 'Les Fourmis de la Suisse,' 1874, pp. 328, 329.

† 'Ants, Bees and Wasps,' London, 1888, pp. 36–40.

‡ 'A Study of an Ant,' *Proceed. Acad. Nat. Sci. Phila.*, July, 1901, p. 439.

§ See also Pérez, 'Mémoire sur le Ponte de L'Abeille Reine et la Théorie de Dzierzon,' *Ann. Sc. Nat.*, 6 ser., Tome VII., Art. 18, 1878, pp. 1–22.

effects of a brilliant theory like that of Dzierzon, backed by the weighty argumentation of a von Siebold, and the way it flatters our ineradicable tendency to formulate, conceptualize and schematize in advance of all exhaustive study of nature's processes.*

I find the following observations on a fungus-raising ant, the 'Sauba' (*Atta cephalotes*) of Trinidad, recorded by Tanner:†

My 'B' nest had neither queen nor male when it was set up on the 4th July; a few larvæ and pupæ were put into the nest at starting. The last of these became an ant on the 14th August, 41 days after capture.

The first eggs were seen 19 days after the capture, viz., on the 23d July. Very many small, medium-sized and large ants were matured from these eggs before its [the nest's] destruction on the 6th November, in periods of from 57 days for the smallest to 74 days for the larger ones. On the 20th October a male was matured, on the 3d November there were 25 males. On the 2d November a queen was matured, and another on the 5th, three days later, and their period was about 84 days. Thus, there are about 10 days for the egg, as a larva it varies from 27 days for the smallest workers, 44 days for the ordinary workers and 54 for males or queens and 20 days for the pupa stage. * * *

It is, therefore, as far as this experiment goes, conclusive, that workers, taken as these were from a nest which had been living in community with males, do lay eggs; and that from them they can produce males and queens.

Tanner's observations go to show that the eggs of *Atta cephalotes* workers may give rise to ants of all three sexual forms, that is, males, females and workers of the different castes so remarkably developed in these large fungus-raising ants. The implication in the last quoted paragraph, that the production of all these forms depended on the fertile workers having come from a colony containing males, may be gratuitous (*vide infra*).

More important observations on this subject have been recently made by H. Reichenbach, a very conscientious worker.*

I quote his results in full:

In the spring of 1899 I placed in an empty artificial nest of the Janet pattern eleven workers of *Lasius niger* L., more for the purpose of showing my pupils the commonest of our ants, than for the purpose of conducting definite observations. I fed them with invert sugar and hashed meal-worms. Even after a few days I noticed several packets of eggs which had been laid by the workers. This was nothing new to me, and I expected that to happen which had happened in my other colonies, namely, that the larvæ hatching from such eggs would succumb to the cannibalism of the ants. At most I supposed that I might obtain males, since it has long been known that males arise from unfertilized eggs laid by workers, as in the case of the honey-bee and the social wasps.

But to my astonishment, the larvæ pupated and produced *typical workers*, which agreed with their progenitrices even in size. A few days later they had acquired their mature coloration and began to take part diligently in the labors of the colony.

Thus it is possible that workers may develop from unfertilized eggs laid by workers.

A little later the number of egg-packets increased, and towards the end of June the number of workers had risen to over a hundred, and a number of larvæ and pupæ were being busily carried about, assorted, fed and licked; the ants' appetite was excellent, the glass manger was found licked clean every morning; pupa-cases,

* Absence of critical caution in accepting the Dzierzon theory is seen, for example, in works like Castle's 'Heredity of Sex,' when the author makes the following apodictic statement (p. 191): 'That the spermatozoon also bears sex is manifest in the case of animals like the honey-bee, for the egg of the bee, if unfertilized, invariably develops into a male, but if fertilized into a female. Professor T. H. Morgan, in his recent work, 'Evolution and Adaptation,' pp. 424, 425, makes a similar statement: 'In the honey-bee all the fertilized eggs produce females and the unfertilized eggs males'; although he proceeds to cite the conditions in an insect of the same natural order as the bees and ants, namely the currant-fly (*Nematus ribesii*), which may, under certain conditions, produce both males and females from parthenogenetic eggs.

† *Œcodoma cephalotes.* Second paper. Trinidad Field Naturalists' Club, Vol. I., No. 5, December, 1892, pp. 123–127.

* 'Ueber Parthenogenese bei Ameisen und andere Beobachtungen an Ameisenkolonien in künstlichen Nestern,' *Biol. Centralbl.*, 22. Bd., 1902, pp. 461–465.

remains of meal-worms, etc., were very neatly piled up in a particular corner of the middle chamber;—in brief, the life and activity of the ants were perfectly normal, notwithstanding the rather peculiar provenience of most of the inmates of the nest.

During the normal course of colonial life the following occurrences were noticed:

During the last week of August, as it were on the very day, when in the gardens and streets of Frankfurth, winged males and females of *Lasius niger* creep about as weary relicts of the nuptial flights, about a dozen fine, shining males hatched in my colony. When they had taken on their adult coloration, they sought the illumined chamber and walked about nimbly. Had it been possible for them to escape, they would certainly have joined in the nuptial flight of the mass of their species out-of-doors.

The males lived only a few weeks; most of them met with an accidental death through becoming glued down with their wings.

The colony passed the winter in good condition, and in the spring of 1900 a rapid increase again took place from eggs laid by the workers. On the 1st of August I was able to announce to our natural history society that the nest again contained 300 workers and two to three dozen males. This year, also, the appearance of the males coincided with the swarming time out-of-doors.

During the year 1901 the same events were repeated, with the difference that the number of individuals had fallen off; still there were a few males towards the end of July. By the spring of 1902 only about twenty workers survived; larvæ were still being reared, but towards the end of April, for some unknown reason, the whole colony became extinct.

Worthy of note, therefore, is the coincidence, three times in succession, in the appearance of males at the typical time of swarming for our neighborhood. From this we must conclude that the conditions in my colony did not depend on degenerative or similar causes. On the contrary, this decided periodicity points to normal processes, which probably also occur in wild colonies, whose workers, in all likelihood, take part in producing males. Of course, these conditions require further investigation.

He who takes for granted the completeness of our knowledge of propagation in ants, more particularly of mating and fertilization, will regard all the workers of my *Lasius* colony as having developed from unfertilized eggs. But the question arises, whether, after the males made their appearance, some kind of copulation could not take place within the nest, or whether, in fact, some of the eleven workers that founded the colony were not fertilized. Many will deny this with indignation and horror; but one is becoming accustomed to surprises, especially in sexual phenomena. Moreover, fertilization always occurs normally within the nest in the case of *Anergates atratulus* Schenck, which exhibits strict in-and-in breeding. Forel also opens up this question ('Les Fourmis de la Suisse,' p. 401). At any rate, a careful anatomical and microscopic analysis of the ovipositing workers, which are perhaps to be regarded as ergatogynous females, and their eggs, is in every respect important, and this alone would give value to the above observations.

That Reichenbach's supposition of a fertilization of the workers by their male progeny in his nest is unnecessary, is shown by the following observations kindly sent me by Mrs. A. B. Comstock, and published with her consent:

About the middle of August I colonized some ants of the species *Lasius niger* L. var. *americanus* Emery, in a glass nest in my room for the purpose of giving my pupils in nature study an opportunity for observing the habits of ants. I found this species common under the stones on a dry side hill, and I brought in, with the workers, pupæ and larvæ of two sizes and some eggs still unhatched. My prisoners soon put their nest in order and placed the pupæ in two separate heaps, and separated the larvæ into two groups according to size, and also placed the eggs by themselves. After a day or two the eggs hatched and these young larvæ were kept in a group away from the others. A few days later more eggs appeared. I at once looked for the queen but found none. No one ant in my colony was any larger than her sisters, and I was mystified as to the source of these eggs. However, they continued to appear; and there have been reared in this nest up to date at least three complete broods. We naturally expected that the eggs which were evidently laid by workers would produce males as is the case with bees. But this theory was wrong, for *all the eggs laid by the workers in this nest have developed into workers.* I have never been able to observe the actual process of egg laying. I am rather inclined to believe that the eggs were usually produced during the night. There was nothing in actions or appearance that enabled me to distinguish the egg-laying indi-

viduals from their sisters. I have noticed that when eggs were being produced a large number of the ants were crowded together in one corner of the nest, and only a few seemed to be on duty as nurses. Whether this segregation has to do with the egg laying or not I do not know.

In this case no males have as yet made their appearance. So accomplished an entomologist as Mrs. Comstock could not have overlooked either these or a queen in her colony, especially as the latter sex in *Lasius* is very much larger and more conspicuous than the worker.

While the observations above quoted are by no means final, they are, nevertheless, of sufficient value to call a halt to all speculation based on the Dzierzon theory formulated in the usual text-book style. As thus expressed this theory can at most be valid for the honey-bee only. The probability that worker ants can really produce other workers or even queens parthenogenetically is of ominous import, not only to some current views on sex determination, but also to many fine-spun theories of instinct and organic development. It has been generally admitted that worker insects have their own specific instincts (a proposition not strictly true, as I have endeavored to show,* since the instincts of the queen ant include all or nearly all the important worker instincts), and that these insects are smitten with such complete sterility as to be absolutely incapable of transmitting their inherited or acquired psychical or physical characteristics. Hence, it is urged, we can explain the existence of these worker traits only by resorting to a natural selection among the queens as bearers of characters which they do not themselves exhibit or exercise. Hence the additional sets of ids, etc., hypostasized in the germ-plasma of the queens. Or, if we have an innate repugnance to natural selection, we are requested to fall back on something like orthogenesis, some Aristotelian principle of perfectibility or Naegelian 'Vervollkommnungsprincip.' But after reveling in this tenuous atmosphere of hypothesis, which I would be the last to deprecate, since it is the only free playground of the living and struggling scientific imagination, are we not now bound to return to the cold facts and the drudgery of experiment and observation, if only to gain strength for another flight?

* 'The Compound and Mixed Nests of American Ants,' *Am. Naturalist*, 1901, p. 798.

WILLIAM MORTON WHEELER.
AMERICAN MUSEUM OF NATURAL HISTORY.

QUOTATIONS.

THE CARNEGIE INSTITUTION.

THE trustees of the Carnegie Institution held their second annual meeting at Washington on December 9. Nothing that has become known in regard to this meeting will tend to allay the anxiety with which men of science are watching the administration of this great trust. It is reported that Dr. Gilman presented a letter to the trustees announcing his intention to resign the presidency at the close of next year. The institution will consequently drift along for another year, and its immediate future will in large measure depend on the president then chosen. There is no reason to doubt the ultimate outcome, and even the present conditions are only what might have been expected. Special creations are no longer regarded as feasible. The reply may be called to mind of the little boy, who, on being asked who made him, said 'God made me one foot big, and I growed the rest.' A new foundation such as Mr. Carnegie's can only gradually become a true organism adjusted to the environment.

Mr. Carnegie's original plan of establishing a research university at Washington was comparatively plain sailing. The trustees are now divided as to policy, some wishing to establish certain laboratories at Washington, and others perferring to distribute subsidies throughout the country. The latter plan has been adopted; it has the obvious advantage of not committing the institution as to the future. No special objection can be made to the way the subsidies have been allotted. It is quite certain, for example, that the Harvard, Lick, Yerkes, Dudley and Princeton observatories can spend to advantage any money that may be entrusted to them. Almost any grant for research made to men of science of established reputation will bear fruit a hundredfold.

There is, however, an obverse to the shield. Such grants inhibit individual initiative and local support; they are likely to produce a certain subserviency to the powers that deal out money, and may lead to jealousy and intrigues.

It is perhaps scarcely fair to object to a board of trustees consisting chiefly of prominent politicians, lawyers and business men, who meet once a year, and can not be expected to give much attention to the affairs of a scientific institution, nor to have much knowledge of its scope and possibilities. Such boards are an established American institution, controlling universities, banks, etc. Their principal duty is to select efficient officers of administration. But the Carnegie Institution has been unfortunate in its first officers. Three men were largely instrumental in persuading Mr. Carnegie to make the original gift, and they have assumed control of its administration. This triumvirate has been at the same time autocratic and feeble, and has by no means worked in harmony. Antony may be supposed to say to Octavius:

> And though we lay these honors on this man,
> To ease ourselves of divers sland'rous loads,
> He shall but bear them as the ass bears gold,
> To groan and sweat under the business,
> Either led or driven, as we point the way;
> And having brought our treasure where we will,
> Then take we down his load, and turn him off.
> Like to the empty ass, to shake his ears,
> And graze in commons.

Whether after the ensuing war Antony, Octavius or another will or should become Cæsar need not here be considered; but in the meanwhile and perhaps thereafter science will suffer. The fundamental difficulty is that no method has been found for consulting the consensus of opinion of scientific men. An American university has an absentee board in nominal control and a president as benevolent despot; but there is a faculty, which after all is the real university. The Carnegie Institution has no similar body; and until it is formed, it will drift along without compass or rudder.—*The Popular Science Monthly.*

THE RHODES SCHOLARS.

Mr. W. S. MacGowan, Principal of St. Andrew's College, Grahamstown, Cape Colony, writes to the London *Times:*

In the *Times* weekly edition of September 25 you print a letter from 'South Africa' dealing with Dr. Parkin's proposal to select the Rhodes scholars from students who shall have pursued a two years' course at some American or colonial university.

When Dr. Parkin was in Grahamstown a short time ago, he explained his views at some length, but he was careful to tell his audience that they were only partially formed and necessarily incomplete, inasmuch as his colonial tour was not yet finished, although he had completed his investigations in the United States. I think that, when Dr. Parkin comes to present his report to the Rhodes Trustees, it will be found that it is America rather than the Colonies which will be found making this demand. To quote Dr. Parkin's own words to me: "The American professors deprecate any denationalization of their young men." This is, of course, quite right and perfectly natural, but surely in a British colony such a consideration as this is somewhat lacking in weight. I have not yet seen Mr. Hawksley's letter, and only know from Reuter that he has written one on this subject; but, apart from the legal aspect of the question, with which he is so amply qualified to deal, there are several reasons against tinkering with the plan that Mr. Rhodes evolved with a view to securing that his scholars should be *bona fide* undergraduates. The first of these is a financial one.

If the suggestion now being canvassed were universally adopted, viz., that every candidate for a scholarship should take a preliminary two years' course at his home university before proceeding to Oxford, there would instantly be swept from the field all boys whose parents could not afford for them more than an ordinary secondary education. There are many in this colony who could never go to Oxford at all if they were compelled to spend two years at the Cape University first.

Again, if the trustees agree to extend the usual university age in the case of Rhodes scholars, they will be running counter to Mr.

Rhodes's vigorously expressed desire that these young men should have the benefits of the influences of Oxford University at 'the most critical period of their lives.' If their characters are already formed, they are far more likely to alter the tone of Oxford than Oxford is likely to develop them.

Now, as to the desirability of this I offer no comment, I am only concerned with Mr. Rhodes's intention. He desired that poverty, religion, race—nay, even the lack of 'scholarship' itself—should not bar a boy of strong physique and moral character from obtaining one of these splendid prizes. Yet here is a scheme apparently gaining ground where poverty and the lack of scholarship will practically disqualify a candidate, and the application of the character test as outlined by the testator is rendered nugatory.

But it may be said that Mr. Rhodes only defined his ideas in respect of the South African scholarships. That is quite true, but he gave his intimates to understand that his motive was the same in all cases, viz., 'uniting of the Anglo-Saxon race.' That unity will be postponed if educational experts, in their very natural desire to secure the benefit of these great endowments to produce scholars, arrange the regulations in such a way as to eliminate possible leaders of men such as Rhodes was himself. He wanted picked potentialities, but, if I understand his mind aright, they were to be men of action rather than scholars.

RECENT ZOOPALEONTOLOGY.

VERTEBRATE PALEONTOLOGY IN THE UNITED STATES GEOLOGICAL SURVEY.

THE following abstract is published with the permission of the Geological Survey and covers the progress which has been made during the year 1903 on the work which was substantially begun July 1, 1882, by the appointment of Professor Othniel Charles Marsh, of Yale University, as paleontologist on the survey. As is well known, Professor Marsh devoted years to the collection and preparation of materials for a series of elaborate monographs. The work on these was most unfortunately interrupted by his death, but at that time lithographic plates of three monographs, namely, the Brontotheriidæ (60 plates), the Sauropoda (90 plates) and the Stegosauria (54 plates), were completely prepared and printed, together with hundreds of text illustrations. The drawings for the fourth monograph, the Ceratopsia, are on stone but not as yet printed. Practically none of the manuscript for these volumes was ready.

In appointing Professor Henry F. Osborn as Professor Marsh's successor, it was understood that the latter should receive full credit for the years of labor which he devoted to these monographs. The appointment of Professor Osborn was originally as paleontologist, June 30, 1900; in January, 1901, the appointment was changed to geologist and paleontologist.

The unfinished work was begun at once, and has been carried on in two lines: First, the preparation and supervision of the four paleontological monographs; second, the planning of geological field work connected therewith, the latter being of great importance, in order that the vertebrate paleontology of the survey may render service in connection with the stratigraphic history of the continent.

Professor Osborn undertook the preparation of the Titanothere and Sauropoda monographs himself; Mr. J. B. Hatcher, now of the Carnegie Museum, was entrusted with the preparation of the monograph on the Ceratopsia; and Mr. F. A. Lucas, now of the United States National Museum, was entrusted with the preparation of the Stegosauria monograph.

More in detail, the actual work on hand and accomplished is as follows:

1. *Titanothere Monograph.*—This monograph, begun January 2, 1901, has required more time than was anticipated, partly due to Professor Osborn's interruptions by other duties, partly to the unexpected expansion of the subject by the discovery, both in the Oligocene and Eocene, that the titanotheres embraced at least four entirely distinct and independent phyla. To learn the origin, history, succession and extinction of these animals it has become necessary to trace the materials scattered through many museums, at home and abroad. Yale, Princeton, Harvard, Ot-

tawa, Chicago, Washington and Pittsburg museums have been repeatedly visited. Mr. W. K. Gregory was sent to the British Museum of Natural History, London, for a special study of the titanothere material there, and work has also been done through the aid of Dr. Max Schlosser, in Munich. The chief results obtained thus far are: (1) The systematic revision of the entire group of titanotheres; (2) the separation of the contemporaneous phyla above referred to, illustrating the law of local adaptive radiation, and the polyphyletic division of the perissodactyls; (3) the establishment of the law of correlation of skull with skeletal structure; (4) the independent development of the horns in three separate Eocene phyla, illustrating the law of predeterminate evolution. New methods of illustration in photography have been developed especially for this volume, under the direction of Mr. A. E. Anderson.

A special geological expedition to the Fort Bridger Beds, under the direction of Dr. W. D. Matthew, assisted by Mr. Walter Granger, during the summer of 1902, laid the foundation for more exact stratigraphic data concerning the distribution of species, both of the titanotheres and of other mammals. This preliminary survey in a measure tends to replace the lake theory of deposition in the Bridger beds by the flood plain theory already advocated by Professor W. M. Davis. If confirmed, it will give a further blow to the long-prevailing 'lake basin theory,' which, during the previous season, was unsettled in the Oligocene beds by the observations of Mr. J. B. Hatcher and Professor Eberhard Fraas, in connection also with this titanothere monograph. A party from the American Museum, under the direction of Mr. Walter Granger, is now continuing the observations begun last season on the Bridger stratigraphy, and when these results are in, Dr. Matthew will be able to present his report.

2. *Ceratopsia Monograph.*—The assignment of this monograph to Mr. J. B. Hatcher is particularly appropriate, because of the fact that he practically discovered these animals while working for Professor O. C. Marsh under the U. S. Geological Survey; and that the entire collections in the National Museum and the Yale University Museum are due to him. Mr. Hatcher has completed the bibliographical and reference section, as well as the preliminary revision of the principal forms of the Ceratopsia, and has reached very interesting and novel results. By the terms of his agreement with the Survey, materials in the Yale University Museum, through the cooperation of Professor C. E. Beecher, have been further prepared for description; also, materials in the U. S. National Museum and in the American Museum of Natural History.

The necessity of more exact stratigraphic work than that already contained in the previous studies by Cope, Hatcher and others of the vertebrate paleontology of the Cretaceous became apparent in 1902 partly through the studies by Professor Osborn and Mr. Lawrence M. Lambe, under the Canadian Geological Survey, on the fauna of the Belly River region in the Northwest Territory.*

From these it appeared that the union of the Judith River and the Laramie by Cope and Marsh was partly, at least, erroneous, that two distinct vertebrate faunæ were represented, that part of this fauna in Montana, as well as in the Northwest Territory, was older than the Fort Pierre beds. The subject caused widespread interest and discussion. Never was the necessity of the union of accurate paleontological and stratigraphic work more apparent. Accordingly in June, 1903, Messrs. T. W. Stanton and J. B. Hatcher were detailed by the survey for a complete reconnoissance, extending from the Belly River beds in the north across the boundary down into the Judith River country, to terminate with the Converse Co., Wyoming, beds west of the Black Hills. Mr. Hatcher has reported by letter and in SCIENCE the complete success of this trip. The general conclusion is reached that the Judith River and Belly River are fresh-water deposits overlain by a *portion* of the Fort Pierre and distinctly older than the Laramie.

* 'On Vertebrata of the Mid-Cretaceous of the Northwest Territory,' Geol. Surv. Canada, 'Contributions to Canadian Paleontology,' Vol. III. (quarto), Part II., Ottawa, 1902.

3. *Stegosauria Monograph.*—Mr. F. W. Lucas has completed a preliminary outline for his memoir on the Stegosauria, covering principally the materials preserved in the U. S. National Museum. Mr. Lucas has succeeded in bringing together materials for a corrected restoration of *Stegosaurus,* which differs in important particulars from the restoration by Professor Marsh. It is understood that a model of the animal is in preparation for the St. Louis Exposition.

4. *Sauropoda Monograph.*—The first steps in the preparation of this monograph by Professor Osborn have been taken in the collection of additional material, especially in the Como region of Wyoming, where a deposit, unexampled for richness, has been explored and surveyed under his direction during the past six years. Explorations and studies by Messrs. J. B. Hatcher and E. S. Riggs have also greatly enriched our knowledge of these gigantic reptiles. Two entirely new forms of sauropoda have been discovered, and our knowledge of the forms already known has been extended, so that there is reason to hope that the monograph will contain a complete presentation of the skeleton of several of the known genera of these animals.

The exact stratigraphic work on the Jurassic was begun in the year 1901–2 and was provided for by an appropriation, but unfortunately has been interrupted by the inability of Dr. F. B. Loomis, of Amherst College, to survey the chief section at Cañon City owing to other duties. His sections of the Como region and the Black Hills region have, however, been completed and published by the American Museum of Natural History. Professor Eberhard Fraas, of Stuttgart, is also engaged in the study of the notes and collections made with Professor Osborn in the Jurassic, during 1901–2. He reports that his detailed comparison with the European Jurassic is nearly completed.

5. *Geological Results in Previous Years.*—In the spring of 1901 Mr. Barnum Brown accompanied Professor Lester F. Ward on a short trip into the Lower Trias of Arizona, and secured a number of valuable vertebrate remains, especially of the Phytosauria and Labyrinthodontia, among the latter the genus *Metopias,* which was found for the first time in this country. This collection is in the National Museum.

In 1902 Mr. N. H. Darton of the Survey accompanied by Mr. J. B. Hatcher and Professor Eberhard Fraas visited the *Titanotherium* beds of South Dakota with reference to the establishment of the geological levels of the various species. Mr. Hatcher was able to confirm and greatly extend his previous observations in connection with the Survey, finally establishing the stratigraphic succession of the greater number of the species of Titanotheres.

6. *Progress of Vertebrate Paleontology in America.*—This branch of science covers such a broad field, and the collections made by explorations in the west are so extensive and are multiplying so rapidly, that it is gratifying to report that the number of specialists engaged in the field, in museums and in research work, has rapidly increased, there being now upwards of twenty-five workers. A division of subjects and the friendly cooperation of different institutions have been brought about. Some of these researches, especially those of Prof. S. W. Williston on the pleiosaurs, are on so large a scale that their publication should be undertaken by the government. H. F. O.

SCIENTIFIC NOTES AND NEWS.

DR. G. W. HILL, of Nyack, N. Y., has been elected a corresponding member in the section of astronomy of the Paris Academy of Sciences.

THE Nobel prizes, each of the value of about $40,000, were awarded in Christiania, on December 10. The prize in physics was divided between M. Becquerel and M. and Mme. Curie, of Paris. The prize in chemistry was awarded to Professor Arrhenius, of Stockholm; the prize in medicine to Dr. Finsen, of Copenhagen, and the prize in literature to Dr. Björnstjerne Björnsen, of Christiania. The formal distribution of the prizes took place in the presence of the King and several members of the royal family and a distinguished gathering. A program of music was performed and the usual speeches de-

livered, after which the prize-winners present, MM. Becquerel, Arrhenius and Björnsen received their prizes, with the diploma and Nobel gold medal, from the hands of the King. The absent prize-winners, Professor Finsen and M. and Mme. Curie, were represented by the Danish and French Ministers. It may seem somewhat ungracious to call attention to the fact that three of the four recipients are Scandinavians, whereas Nobel wrote in his will 'I expressly direct that in the award of prizes no attention whatever shall be paid to nationality, so that only the most worthy shall receive the prize, whether he be a Scandinavian or not.' It is also the case that, contrary to the express directions of Nobel's will, about half the income of the fund has been diverted to local uses.

Sir William Ramsay, of London, will give a course of lectures during the summer session at the University of California on 'The Constituents of the Atmosphere and the Emanations from Radium.'

Professor George W. Hough, of Northwestern University, has been elected an associate member of the Royal Astronomical Society.

Professors Boveri (Würzburg), Fürbringer (Heidelberg), Hilbert (Göttingen), Graf zu Solms-Laubach (Strassburg), Weber (Strassburg) and Wiesner (Vienna), have been elected corresponding members of the Munich Academy of Sciences.

We regret to learn that Dr. Finsen, of Copenhagen, well-known for the discovery of the light treatment of lupus, is dangerously ill.

Professor L. C. Miall has been elected Fullerian professor of physiology at the Royal Institution, London.

Dr. H. A. Bumstead, assistant professor of physics at Yale University, will spend a year at Cambridge working in the laboratory of Professor J. J. Thomson.

Professor W. D. Halliburton, F.R.S., of London University, will give the Herter lectures at New York University in the coming year. He has chosen as his subject 'The biochemistry of muscle and nerve.' The lectures will commence on January 4, 1904.

The second Phipps lecture, delivered by Dr. Osler, of the Johns Hopkins University, on December 3, had for its subject 'The Home in its Relation to the Tuberculosis Problem.'

Dr. Alexander Humphreys, president of the Stevens Institute of Technology, gave an address on 'The College Graduate as Engineer,' in the College of the City of New York, on December 15.

Dr. Nordenskjöld gave a lecture at Buenos Ayres, on December 9, at the Teatro Politeama, in which by the aid of a magic lantern he gave a detailed account of his Antarctic expedition. He stated that he would make known the scientific results of his expedition later, having as yet had no time to coordinate them. M. Skottsberg, the naturalist of the party, gave a full description of the loss of the *Antarctic*.

We learn from *Nature* that the Rev. T. R. R. Stebbing, F.R.S., has been elected zoological secretary, and a member of the council, of the Linnean Society in succession to Professor G. B. Howes, F.R.S., who has had to retire on account of ill health.

The tercentenary of the death of William Gilbert, which occurred on November 30, 1903, was celebrated by the British Institution of Electrical Engineers. Papers were read by M. Hospitalier, and Dr. Behn-Eschenburg, and a picture was presented to the city of Colchester, where he was born.

The body of Herbert Spencer was cremated at Hampstead, on December 14. The Hon. Leonhard Courtney, M.P., made an address. The trustees under Spencer's will are the Hon. Auberon Herbert, Dr. Charlton Bastian and Dr. David Duncan. The executors are Mr. Charles Holme, proprietor of the *Studio*, and Mr. Frank Lott, of Burton-on-Trent. As is generally known, Spencer's autobiography was left stereotyped and ready for the press, and its early publication may be expected.

Benjamin Franklin Koons, professor of natural history and curator of the Museum of the Connecticut Agricultural College, died at

Storrs, Conn., on December 17, at the age of fifty-five years.

WE learn from the London *Times* that a meeting was held on December 10 at the Phototherapeutic Institute, Copenhagen, in celebration of Professor Finsen's success in obtaining the Nobel prize for medicine. It was announced that Professor Finsen had decided to give 50,000 kroner from the amount awarded to him to the institute, and that two members of the governing body would each present it with a like sum.

THE following bill has been introduced into the House of Representatives by Mr. Shafroth and referred to the committee on coinage weights and measures.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That on and after the first day of January, nineteen hundred and five, all the Departments of the Government of the United States, in the transaction of all business requiring the use of weight and measurement, except in completing the survey of public lands, shall employ and use only the weights and measures of the metric system; and on and after the first day of January, nineteen hundred and six, the weights and measures of the metric system shall be the legal standard weights and measures of and in the United States.

THE following are the lecture arrangements at the Royal Institution before Easter: A Christmas course of lectures (illustrated by lantern slides and adapted to a juvenile auditory) on Extinct Animals, by Professor Ray Lankester; Professor L. C. Miall, Fullerian professor of physiology, R.I., six lectures on the Development and Transformations of Animals; Mr. E. Foxwell, three lectures on Japanese Life and Character; Dr. E. A. Wallis Budge, two lectures on the Doctrine of Heaven and Hell in Ancient Egypt, and the Books of the Underworld; Mr. G. R. M. Murray, three lectures on the Flora of the Ocean; Mr. A. D. Hall, three lectures on Recent Research in Agriculture; Professor H. L. Callendar, three lectures on Electrical Methods of Measuring Temperature; Mr. Sidney Lee, two lectures on Shakespeare as Contemporaries knew him; Mr. J. A. Fuller-Maitland, three lectures on British Folk-Song (with vocal illustrations); Mr. W. L. Courtney, two lectures on Comedy: Ancient and Modern; and six lectures by Lord Rayleigh on Physics. During the season 1904 the lectures on Tuesdays and Thursdays will be delivered at five o'clock, and the Saturday lectures at three o'clock. The Friday evening meetings will begin on January 15, when a discourse will be delivered by Lord Rayleigh on Shadows; succeeding discourses will probably be given by the Rev. Walter Sidgreaves, Mr. D. G. Hogarth, Mr. Alfred Austin, the Dean of Westminster, Mr. H. Brereton Baker, Mr. Alexander Siemens, Professor W. Stirling, Professor F. T. Trouton, Mr. Henry Arthur Jones, Professor Dewar, and other gentlemen.

SIR NORMAN LOCKYER, as we learn from the London *Times,* was the chief guest at the annual dinner of the Sheffield University College on Friday night, December 4. His recent address at Southport as president of the British Association was followed, he said, by 200 leading articles in the newspapers. A great majority of those articles were in favor of the views that he urged, one of those views being that a considerable sum should be set apart by the nation so as to put its educational house in order. Some objections were raised to that address. There was the question of the sum necessary to do this educational work. The sum he estimated as necessary in relation to the actual conditions at the various centers of learning was the sum, capitalized, of £24,000,000—not 24 millions a year. He did not ask for the making of eight new universities; he merely pointed out that England had a commerce to defend and was determined to defend it; that we had gone about that task in a common-sense way and were resolved to be twice as strong as our neighbors, and, carrying out that principle, had built a two-power navy; and he simply suggested that universities were as important in one direction as battleships were in another, and it seemed rather a pity that, if in the matter of battleships England was going to be twice as strong as one power, we should be content to remain only half as strong as one power in regard to universities. There was another critic of his scheme who called it grandiose. But he would like to point out that 24 millions at 2½ per

cent. only meant getting an income of £480,000 a year. That sum of £480,000 was just about half the sum which the German government passed over every year to the German universities. Could it be said that half the sum that Germany gave to her universities was 'grandiose'? Was it not rather mean? Another objection to his Southport address was that he began at the wrong end—with the universities instead of with primary education. But surely, when the British government had in the last thirty years spent 420 millions sterling on primary schools, primary education could be regarded as the affair of the government and very properly left in its hands. He at any rate did not wish the stream of education to be dammed in any way by anything. Let every British child begin at the best primary school it could get, and end, if it was capable, at the best university it could get.

The Government of India reports, according to an abstract in the London *Times,* that in 1901 more human beings were killed by wild animals than in any year since 1875 except one, and reached a total of 3,651, while last year it was 2,836, and the number of deaths from snake-bite was 23,166. Tigers killed 1,046 persons, of which 544 occurred in Bengal, 65 being in a single district. This was due to the depredations of a man-eater, for the destruction of which a special reward was offered without avail. In another district where 43 persons were killed most of them fell victims also to a man-eater. Wolves slew 377 persons last year, of whom 204 were killed in the United Provinces. A campaign was undertaken against these animals in Rohilkhand and the Allahabad division, and they have been almost exterminated in Cawnpore district, where they used to abound. 80,796 cattle were killed by wild animals last year, and 9,019 by snakes. Tigers killed 30,555 of these, leopards 38,211, and wolves and hyenas most of the remainder. On the other hand, rewards were paid last year for the destruction of 1,331 tigers, 4,413 leopards, 1,858 bears, 2,373 wolves, and 706 hyenas, while the number of snakes killed for reward was 72,595.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. Atwood Matthews has bequeathed £5,000 each to the general funds of the university and of Trinity College, Cambridge, and the Hon. George Charles Brodrick has bequeathed £4,000 and his pictures and engravings to Merton College, Oxford, of which he was warden.

Marsh Hall, occupied by the Yale Forest School was injured by fire on December 11, the loss being estimated at about $10,000.

The College Entrance Examination Board of the Middle States and Maryland, which was organized three years ago to direct the entrance examinations of the principal colleges and universities in the east, has extended its influence to such a degree that it has now dropped the qualifying phrase and is now 'the College Entrance Examination Board.' The examiners for the current year include the following: *Mathematics*—Chief Examiner, Professor Frank N. Cole, Columbia University; Associates, Professor Thomas C. Esty, University of Rochester, and Dr. Arthur Schultze, De Witt Clinton High School, New York City. *Physics*—Chief Examiner, Professor Edward L. Nichols, Cornell University; Associates, Professor Francis C. Van Dyck, Rutgers College, and Frank Rollins, Morris High School, New York City. *Botany*—Chief Examiner, Professor William F. Ganong, Smith College; Associates, Professor Henrietta E. Hooker, Mount Holyoke College, and Louis Murbach, Central High School, Detroit, Mich. *Chemistry*—Chief Examiner, Professor Leverett Mears, Williams College; Associates, Professor Charlotte F. Roberts, Wellesley College, and Albert C. Hale, Boys' High School, Brooklyn, N. Y.

Mr. Lewis Burton Alger, Ph.B. (Michigan), A.M. (Columbia) has been appointed junior professor of education at the University of Michigan.

Mr. W. C. Fletcher has been appointed to the newly established post of chief inspector of secondary schools in Great Britain. Mr. Fletcher was second wrangler at Cambridge in 1886.